GENERATION, TRANSMISSION AND APPLICATION OF THE POWER SERVICES

Power

A McGRAW-HILL PUBLICATION FEBRUARY 1955·50¢

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Paid circulation this issue: over 45,000

NOW! FULL AUTOMATION OF FLYASH REMOVAL

...with A·S·H *Automatic Handling Systems*

Increased handling rates, less manpower, elimination of human error—these are the advantages of full automation with Allen-Sherman-Hoff Automatic Flyash Removal Systems.

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FLEXIBILITY AN IMPORTANT FEATURE—The flexibility of A-S-H systems makes it possible to extend automatic control to collecting and storage apparatus with all necessary crossovers and check features. Control can be used to interlock two or more complete systems.

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GRAPHIC PANEL TELLS WHAT IS GOING ON—WHERE—An integral light panel indicates the operational sequence through the entire system. An instrument on the control panel indicates the prevailing vacuum. When required a recorder can be furnished to register the operating vacuum throughout the complete removal process—providing a permanent record for the operator's review and study.

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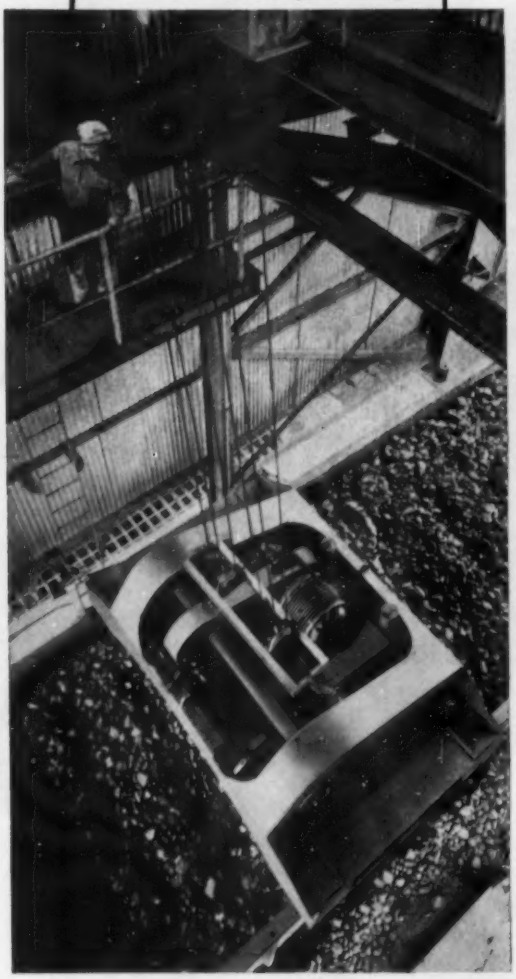
CAR SHAKERS for 15 or more cars per day



ROTARY DUMPERS for 15 or more cars per hour

Empty a 90-ton gondola car every 60 seconds or less (including return to upright position) by turning car upside down! Simple, automatic, foolproof. Takes all open-type cars—any length, width or height. Book 2048-A has complete data.

Cut unloading time—free manpower. For example, where a load of wet coal ties up three men for ¾ hours, one man with a Link-Belt Car Shaker can empty the car "broom-clean" in minutes. Exclusive low-frequency vibration minimizes noise . . . is easier on cars. Write for Book 2345.

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Choose a railroad car unloading system adequate to meet your needs when operating at full plant capacity. Link-Belt builds the Rotary Dumper for large plants . . . the Car Shaker for smaller operations. Precision engineered, both reduce operational hazards . . . minimize injury possibilities . . . cut costly demurrage charges.

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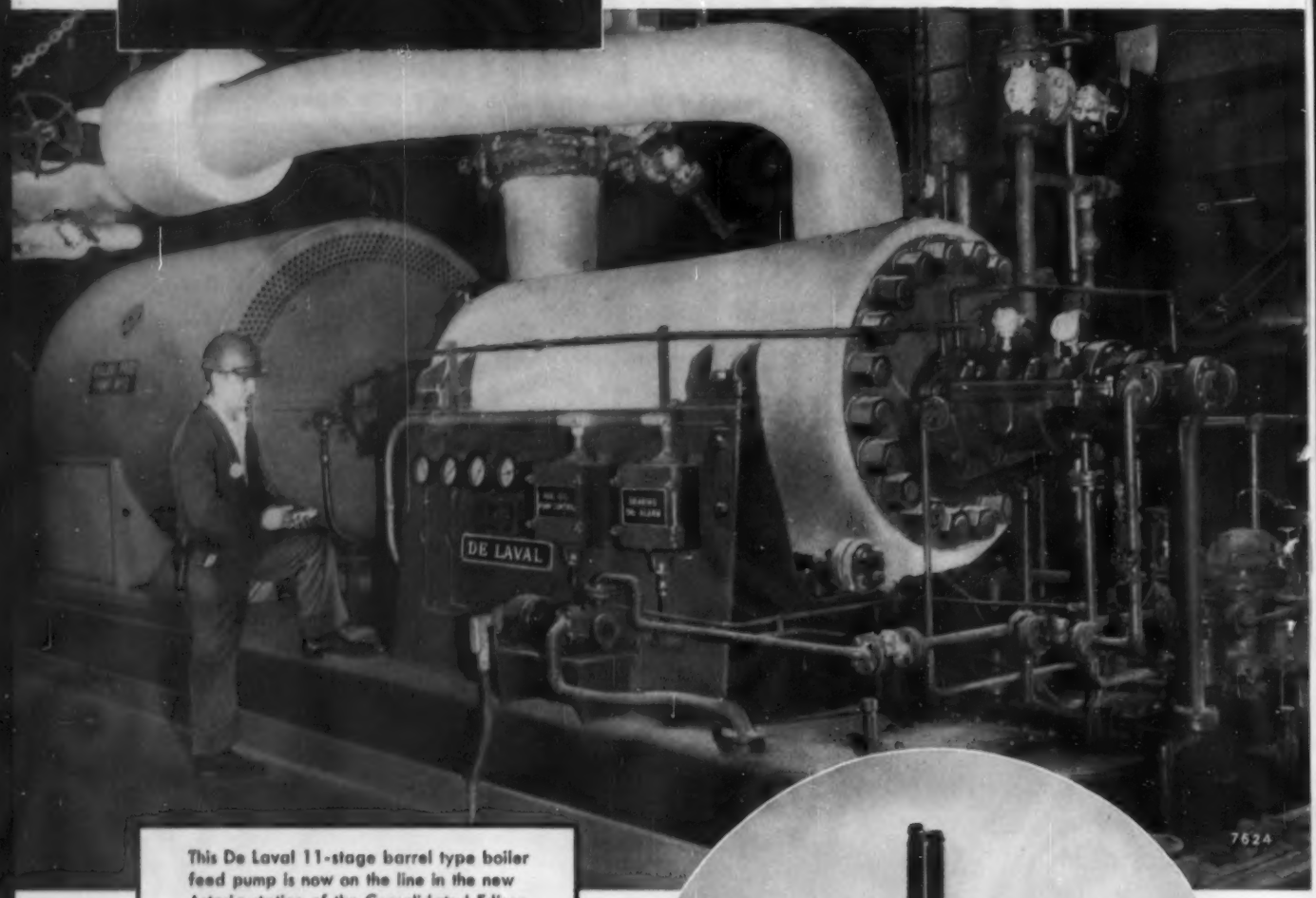
LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 18.710

DE LAVAL
BARREL TYPE BOILER FEED PUMP

in new Con Edison Astoria power station



This De Laval 11-stage barrel type boiler feed pump is now on the line in the new Astoria station of the Consolidated Edison Co. of New York.

The De Laval 8/6 pump operates at 129 psig suction pressure and delivers 1,570 gpm of 344 F water against 2,229 discharge pressure. Direct-connected at the end of the boiler feed pump shaft is a De Laval IMO pump for lubrication of the main pump and motor bearings. Also furnished is a motor-driven De Laval IMO auxiliary oil pump with pressure controlled switches. De Laval barrel type boiler feed pumps meet all the requirements of high pressure, high temperature boiler feed service. The distinctive De Laval design assures years of reliable operation with minimum maintenance.

DE LAVAL *Boiler Feed Pumps*

DE LAVAL STEAM TURBINE COMPANY

815 Nottingham Way, Trenton 2, New Jersey

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Power

FEBRUARY 1955 • VOLUME 99 NUMBER 2

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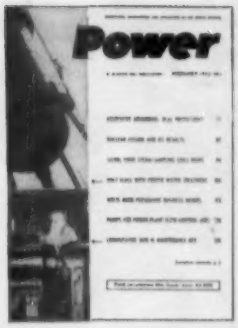


THIS MONTH'S COVER features water treatment and commutator maintenance in its illustrations. It also lists a number of the major articles in the issue. This cover layout is what editors call a change of pace, because it is so different from recent ones.

Next month . . .

■ Steve Elonka will be on deck with his latest practical manual—"Mechanical Packing." This 24-pager in March cuts horizontally across industry, dealing with packing basics. The information it gives has never been completely told in print.

Every man who buys packing, designs equipment using it, or tightens glands can benefit from the facts Steve puts into his easy-going style. So don't miss this opportunity for getting the latest information on mechanical packing. We know it will prove a big help on any job using packing.

■ Be sure to read our lead article in March. Associate Editor Jim O'Connor has been tracking down red-hot leads on up-to-the-minute facts of turbine lubrication. Some changes taking place are eye openers you shouldn't miss.

■ Ever dream of having your plant at the mouth of a coal mine? That's just what the Utah Power & Light Co has in their Carbon Plant at Castle Hill, Utah. Located in a rough, barren canyon, it has several unusual features. See it in the March issue.

■ Saving $3000 per day in plant operation would interest any engineer. In March you'll see how Goodyear Tire & Rubber Co, winner of a 1954 modernization citation by POWER, did just this. And don't miss the 1955 announcement, p 81 of this February issue.

. . . and future months

■ June brings a major Special Report on today's electric motors. Covering all types of motors, it includes ratings, insulation, bearings and lubrication, stators, rotors, fields, armatures and matching the motor to its load. An outstanding feature will be its coverage of design.

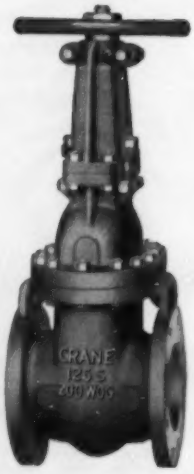
Testing...testing...50 years and longer to make CRANE VALVES maintenance free

Testing for product performance values is an old custom with Crane. It was started long before many standards existed—long before others in the field used this means of product improvement and quality control.

Today's Crane valve testing is done in both field and laboratory by the most scientific techniques. This continuing work seeks to increase valve performance and lessen maintenance needs. A single example is the stem packing test shown above.

Here's one of the reasons back of the thrifty buyers' preference for Crane valves. They can rely on ever-improving Crane quality to protect their company's investments in piping equipment—especially today, in the face of high maintenance and repair costs. No wonder industry keeps using more Crane valves than any other make.

Better Quality
Bigger Selection
in Valves
for Every Need



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CRANE'S FIRST CENTURY . . . 1855-1955

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...with Power readers...

AMERICA'S FIRST DIESEL?

Most editors have a bit of Sherlock Holmes in them—they'll track down a likely looking clue for months (sometimes even years) to come up with an interesting item for their readers. That's just what happened last July when our long-time friend, Ed Fish, retired chief engineer of Hartford Steam Boiler Inspection & Insurance Co, wrote in part:

. . . In 1897, Adolphus Busch, president of Anheuser-Busch Brewing Co of St. Louis, visited Germany. While there, a new type engine, the diesel, was brought to his attention. It appeared to have so many possibilities he called on his friend, Col E D Meier, president of the Heine Safety Boiler Co, as an engineer whose technical opinion of the engine would be of value.

He asked Col Meier to come to Germany immediately to study the engine. Meier did, and on the basis of his recommendation Busch purchased the American and Canadian rights to the diesel engine.

Busch arranged with Dr Diesel to have a small demonstration unit built to display in the U.S. The purpose of the unit was to

(*Continued on page* 214)

...lines and bylines

DEVELOPMENT of load-center distribution principles for industrial power systems is but one item on a long list of outstanding experiences chalked up by R H Kaufmann, author of the equipment grounding article, beginning on p 77 of this issue.

R H Kaufmann

Other important work includes planning the design and arrangement of many large industrial power systems. This entails voltage-regulation studies, short-circuit analysis and selection of appropriate protective interrupters, relay studies and selection. During the last war he developed basic practices for aircraft dc electrical systems. Coauthor of a book on this subject, Kaufmann also has many technical papers and articles to his credit. Equipment grounding is a natural adjunct to his extensive work on industrial power systems. He holds patents for new and novel power systems he conceived.

SAFETY HEADS, or prebulged rupture disks, p 101, have been Jim Myers' concern with Black, Sivalls & Bryson, Inc, for the past 17 years. Starting with BS&B 19 years ago, Jim served an apprenticeship of about a year in the firm's Oil Field Division.

J F Myers

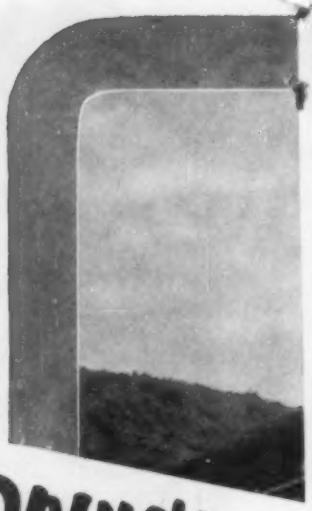
During this time he was considered a "roustabout" since his duties consisted of erecting steel and wooden storage tanks, walkways, oil-and-gas separators, treaters, etc.

Entering the BS&B Safety Head Division, Jim spent 12 years in close contact with all phases of the work of his Division. For the last five years he has been sales manager of the division.

Jim is a member of the API Manufacturers' Subcommittee on safety and relief valves, and the National Fire Protection Association. Favorite hobbies are tennis and golf (time permitting).

SOME TIME BACK we received a fascinating model of a Corliss engine from M S Jones of Baltimore. His letter accompanying the carefully boxed model told how he received it as a premium about 1902 for sending 25 $1 subscriptions to POWER. Searching our files we found it was first offered to readers in February 1899. Being completely adjustable, it was an excellent study aid.

The model was displayed in POWER's booth at the recent Power Show, along with a nuclear-fission chain-reaction model built by Associate Editor Ben Skrotzki's son, Paul. The two gave visitors a good idea of the advances in power generation in the last 50 years. At the Show we were overjoyed to have Jones, shown below with Lou Rowley, Editor of POWER, stop by to point out the features of his model.



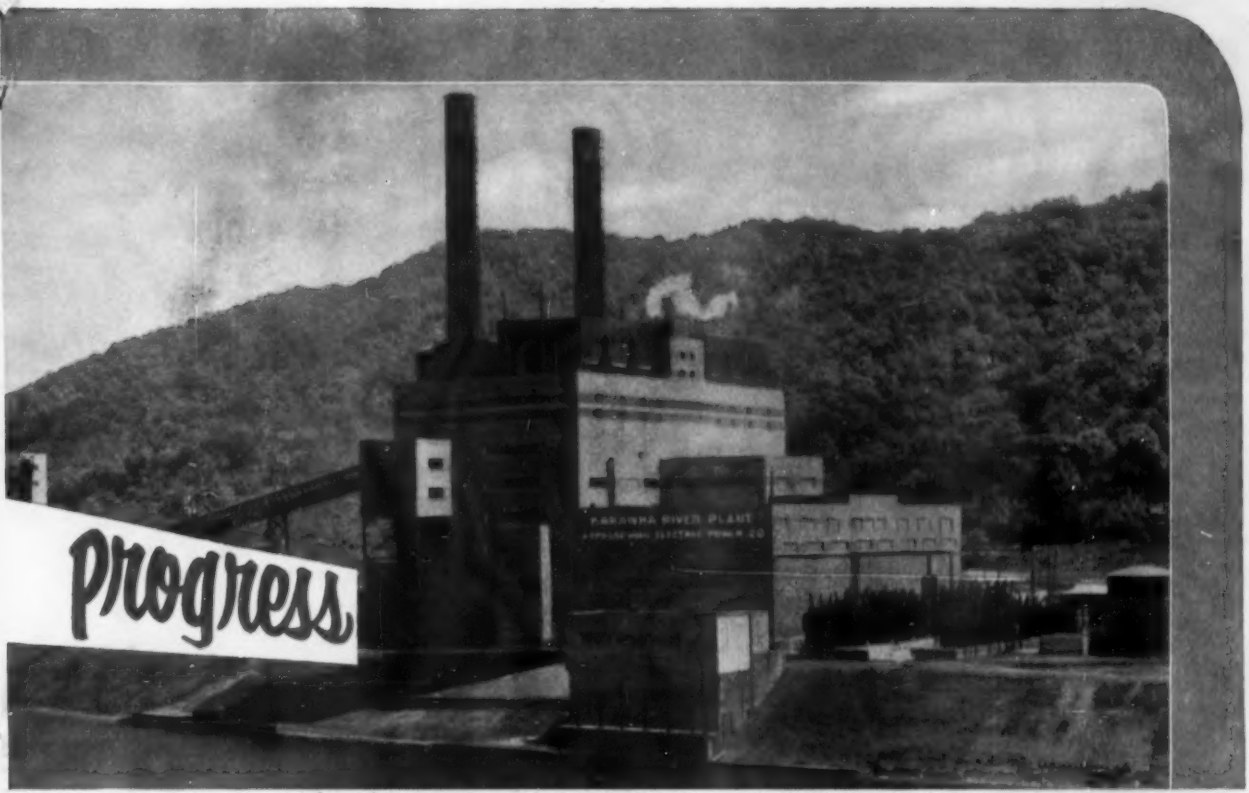
Pacing the nation's power

10 BEST ANNUAL HEAT RATES

(Plant Net Heat Rates)
Btu per kwhr*

9170 KANAWHA	**Appalachian Electric Power Co. on the American Gas and Electric System—** Two B&W Pressure-Fired Radiant Reheat Boilers with Gas Recirculation and Divided Furnace Construction.
9329 TANNERS CREEK	**Indiana and Michigan Electric Co. on the American Gas and Electric System—** Three B&W Pressure-Fired Radiant Reheat Boilers with Gas Recirculation and Divided Furnace Construction.
9418 ALBANY	**Niagara Mohawk Power Corporation.**
9454 SCHILLER	**Public Service Co. of New Hampshire—** Two B&W-built Mercury Boilers.
9510 DUNKIRK	**Niagara Mohawk Power Corporation.**
9540 J. R. WHITING	**Consumers Power—** Three B&W Radiant Reheat Boilers.
9594 PHILIP SPORN	**Appalachian Electric Power Co. and The Ohio Power Co. on the American Gas and Electric System—** Four B&W Pressure-Fired Radiant Reheat Boilers with Gas Recirculation and Divided Furnace Construction.
9630 ST. CLAIR	**Detroit Edison Co.—** Four B&W Radiant Reheat Boilers with Gas Recirculation and Divided Furnace Construction.
9661 EASTLAKE	**The Cleveland Electric Illuminating Co.**
9815 ASTORIA	**Consolidated Edison Co. of New York, Inc.—** Two B&W Pressure-Fired Radiant Reheat Boilers with Gas Recirculation and Divided Furnace Construction.

* Federal Power Commission figures



Appalachian Electric Power Company's Kanawha River Plant on the American Gas and Electric Company System.

Headed by a record 9170 Btu per net kwhr, these ten plants were the most efficient central stations in the country during 1953, the most recent year for which complete heat rate data are available.

Reflecting the decision of the electric companies to utilize the most recent engineering advances, even during a time of critical capacity expansion, the outstanding performance of these modern plants is a tribute to the foresight of the whole industry. It affords one more indication that the prime interest of this unique team of electric companies and their major suppliers lies in producing still lower-cost kilowatts for a still greater America.

B&W Boilers in many of these stations are designed with such advances as Pressure-Firing, Cyclone Steam Separators, Gas Recirculation and Divided Furnace Construction — features which have contributed substantially toward the outstanding efficiency levels achieved. Also, all steam generating units are equipped with reheaters, a development of major importance in improving plant efficiency.

Pressure-Firing

Among the many advantages of this important engineering advance, as utilized, for example, by the Kanawha River units, is elimination of air infiltration to reduce stack loss and assure greater efficiency. Maintenance is reduced and the use of forced-draft fans alone means easier starting, smoother operation and simpler controls. These are the reasons why more than 100 Pressure-Fired B&W units are now in service or under construction.

Cyclone Steam Separators

Operating inside the steam drum, these simple, stationary devices require no power or maintenance and do not take up building room. The Cyclone Separators assure positive natural circulation at high pressure, and with the steam scrubbers, make it possible to send steam of highest purity to the turbine. Consequently, turbine efficiency is maintained and turbine outages reduced.

Divided Furnace Construction

With this B&W construction, building volume is held to a minimum. Both sides of the furnace division wall are used to absorb heat and thus make it possible to achieve the required furnace cooling surface without excessive increase in building volume.

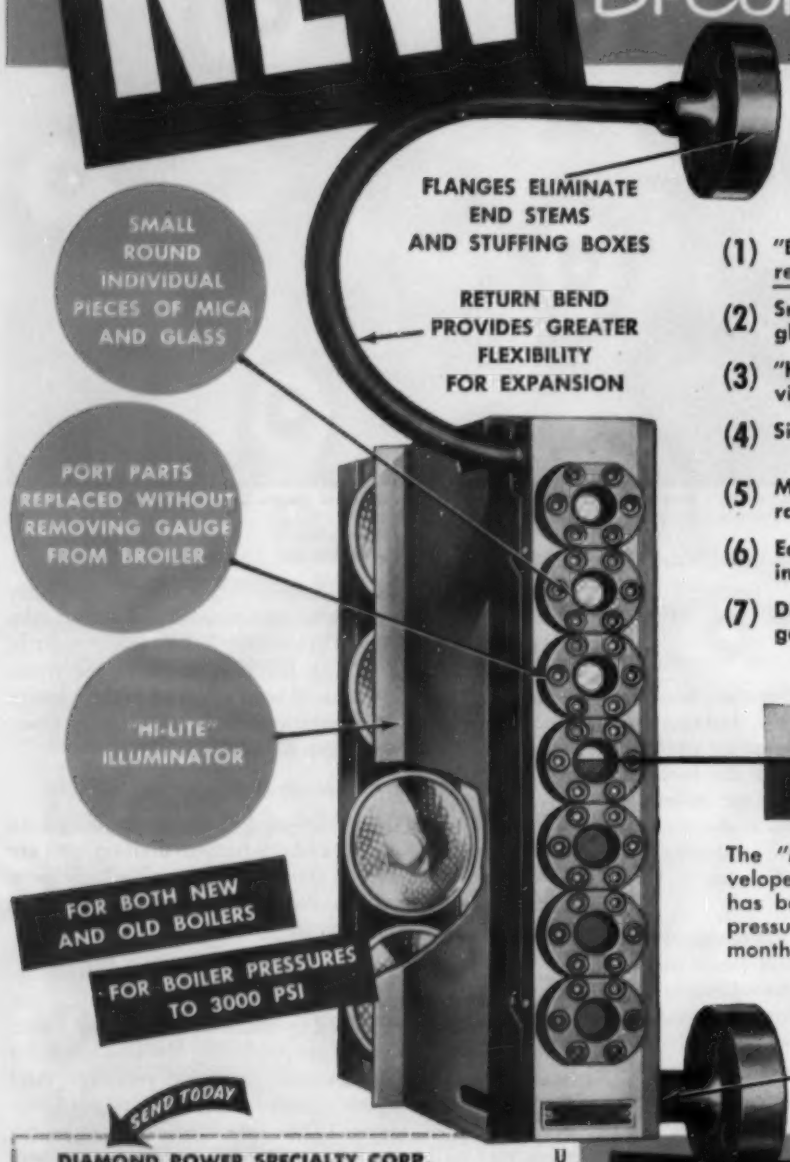
* * * * * *

The record heat rates set by these leading generating stations are closely followed by those of many more plants across the country which are producing low-cost kilowatts at efficiency levels unattainable just a few years ago. And B&W is continuing to devote its energies and its long-accumulated experience to the development of boiler designs that will contribute to still higher levels of steam generating efficiency. The Babcock & Wilcox Company, Boiler Division, 161 East 42nd Street, New York 17, N. Y.

BABCOCK & WILCOX
BOILER DIVISION

G-696

NEW DIAMOND "MULTI-PORT" Bi-Color Gauge


FLANGES ELIMINATE END STEMS AND STUFFING BOXES
RETURN BEND PROVIDES GREATER FLEXIBILITY FOR EXPANSION
SMALL ROUND INDIVIDUAL PIECES OF MICA AND GLASS
PORT PARTS REPLACED WITHOUT REMOVING GAUGE FROM BROILER
"HI-LITE" ILLUMINATOR
FOR BOTH NEW AND OLD BOILERS
FOR BOILER PRESSURES TO 3000 PSI
WELDED CONSTRUCTION ASSURES PERMANENT TIGHTNESS
STEAM SHOWS RED
WATER SHOWS GREEN

"MULTI-PORT" Advantages:

(1) "Bi-Color" principle shows steam red and water green

(2) Small round ports instead of long glass strips

(3) "Hi-Lite" Illuminator for improved visibility

(4) Simplified high-pressure construction

(5) Maximum thermal stability for rapid starting

(6) Easy, inexpensive maintenance . . . in place

(7) Direct reading . . . basic reference gauge

The "Multi-Port" gauge has been developed over a four-year period and has been in continuous successful high pressure operation for more than 18 months in several leading central station plants. For additional information, write for new Bulletin 1174 . . . use the coupon below.

6952

SEND TODAY

DIAMOND POWER SPECIALTY CORP. U
LANCASTER, OHIO

Please send me without obligation a copy of new Bulletin No. 1174 explaining the advantages of the Diamond "MULTI-PORT" Bi-Color Gauge.

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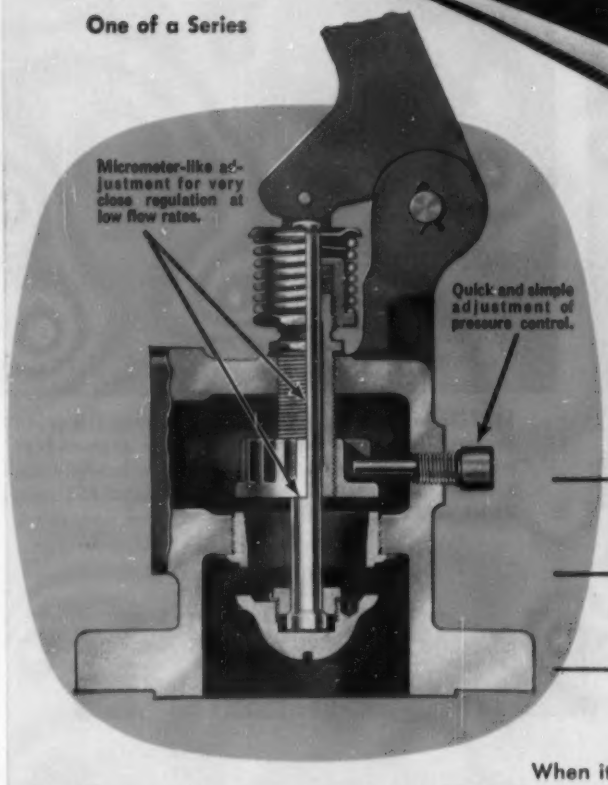
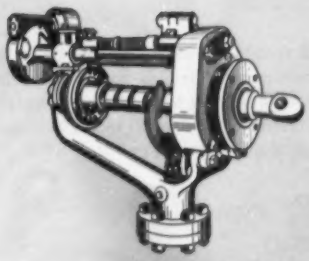
One of a Series

Reasons Why **DIAMOND BLOWERS Assure CLEANER BOILERS at LOWER COST**


Micrometer-like adjustment for very close regulation at low flow rates.
Quick and simple adjustment of pressure control.

ADJUSTABLE PRESSURE CONTROL

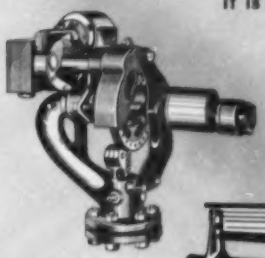


Diamond Model IR
Short Retracting Blower

When it is necessary to reduce blowing medium pressure to proper blowing range, the Diamond Adjustable Pressure Control device offers the utmost in economy, convenience, accuracy and dependability. It is fully effective even at very low flow rates.

Adjustment is readily made without removing the valve or opening flanges. Simply take out the plug and insert a screw driver; use the serrations on the control disc to screw it up for higher blowing pressure . . . down for lower pressure. Full valve opening is always maintained thus avoiding wire drawing. Throttling is at the back seat so that the main seat is spared this damaging action. No orifice is needed in the line.

The Adjustable Pressure Control is one of a number of features of Diamond Blowers which provide better boiler cleaning at lower cost. It is standard on Models G9B, IR and IK. Write for Bulletins.

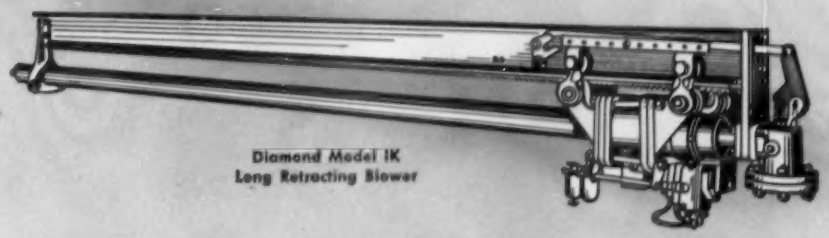


Diamond Model G9B
Automatic Valved Blower

DIAMOND POWER SPECIALTY CORP.

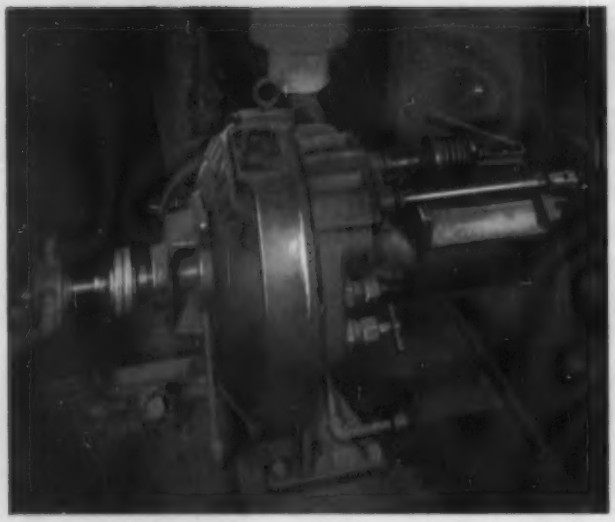
LANCASTER, OHIO

Diamond Specialty Limited, Windsor, Ontario

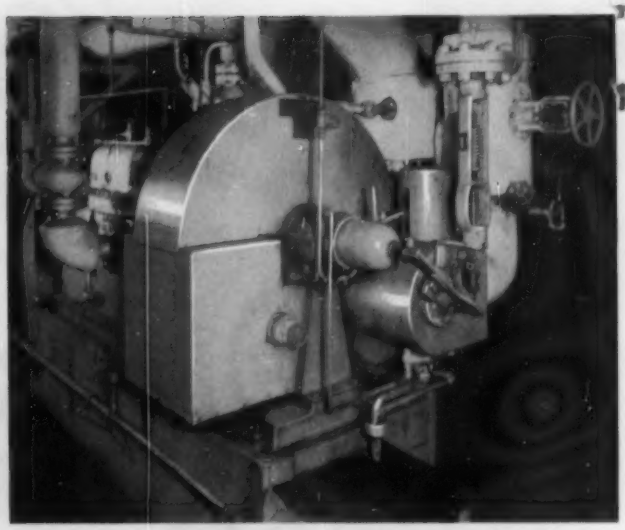


Diamond Model IK
Long Retracting Blower

6775

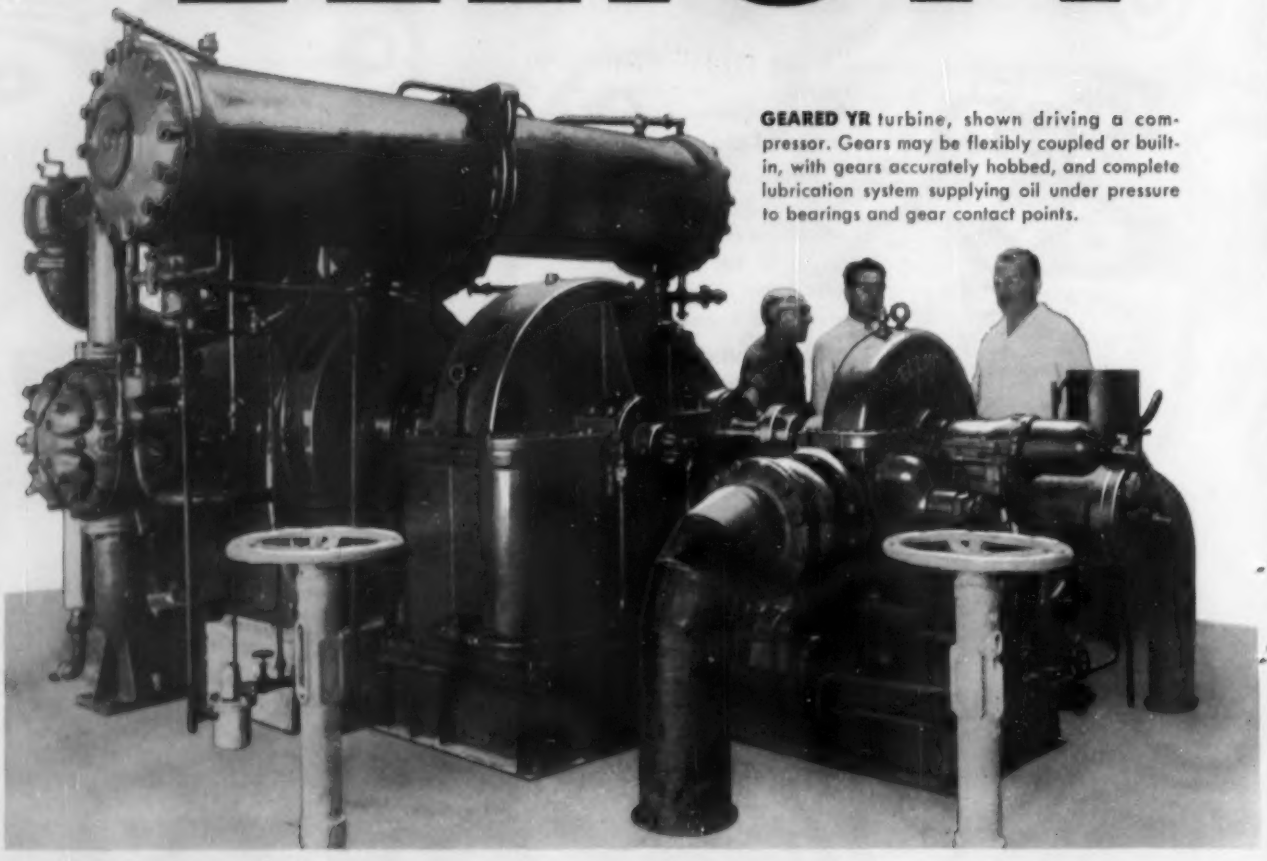


TYPE JR, shown driving a small pump. This is a simplified turbine design of rugged and reliable construction for low horsepower requirements and minimum first cost. Rated up to 45 hp, 4000 rpm. Maximum steam conditions—250 psig, 500 F. and 50 psig exhaust pressure.

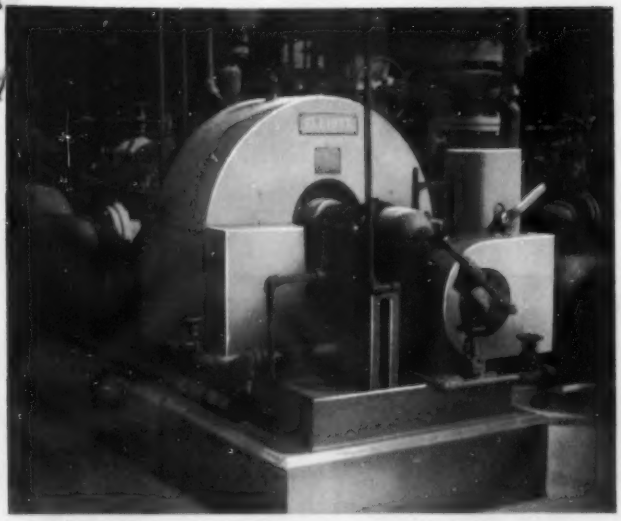


TYPE YR, here driving a boiler-feed pump. This is the standard Elliott mechanical drive turbine preferred all over industry. Five sizes—capacities up to 2000 hp, speeds to 7000 rpm. Steam conditions up to 600 psig, 750 F. and 75 psig exhaust pressure.

ELLIOTT



GEARED YR turbine, shown driving a compressor. Gears may be flexibly coupled or built-in, with gears accurately hobbed, and complete lubrication system supplying oil under pressure to bearings and gear contact points.



HIGH BACK-PRESSURE turbine, shown driving a boiler-feed pump in an oil refinery. These turbines using basic wearing parts of the standard YR, but with extra heavy casing and readily removable extra-packing glands. Good for exhaust pressures up to 250 psig.

MULTISTAGE turbine, shown driving a compressor. Photo shows single-valve turbine, but multi-valve designs can be furnished. Speeds up to 11,000 rpm, steam conditions up to 850 psig, 850 F. Condensing and noncondensing ratings 400 hp and up. Custom-built to your requirements.

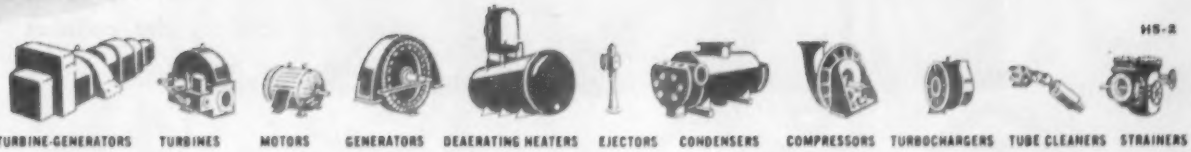
...the name you can depend on for all Mechanical Drive Turbine needs

WHATEVER YOUR REQUIREMENTS, the Elliott line of turbines can provide the simple, reliable answer. From the smallest type JR up to the largest multistage, Elliott mechanical drive turbines have the design, the construction and the flexibility to do the job right.

Contact your local Elliott field engineer or write Elliott Company, Jeannette, Pa. for information and descriptive bulletins.

ELLIOTT Company

HS-2



TURBINE-GENERATORS TURBINES MOTORS GENERATORS DEAERATING HEATERS EJECTORS CONDENSERS COMPRESSORS TURBOCHARGERS TUBE CLEANERS STRAINERS

How to

FORMULA for Cutting Production Costs

(BAILEY Design) + (BAILEY Engineering) + (BAILEY Service)

= GREATER SAVINGS PER FUEL DOLLAR

In the Nela Park central heating plant of General Electric Company, Bailey Meter Control insures efficient use of fuel. It enables operators to run these 18,000 lb per hour 125 psi spreader stoker-fired boilers under optimum conditions at all times.

Save Fuel

★ The productive energy produced by a unit of fuel depends on the way you put it to work in your boiler. How much heat energy you actually get depends upon the performance of your steam plant equipment.

That's where Bailey Controls can help. With a Bailey-engineered control system, you can count on a higher output of available energy per unit of fuel. Here's why:

1. Complete Range of Equipment—fully co-ordinated

You need never worry that a Bailey Engineer's recommendation is slanted in favor of a particular type of equipment, as might be the case if he had only a limited line to sell—or that Bailey will pass the buck for efficient control; we offer *complete* boiler control *systems.*

2. Engineering Service—backed by experience

No other manufacturer of instruments and controls can offer as broad an experience based on succesful installations involving all types of combustion, flow measurement, and automatic control.

3. Direct Sales-Service—conveniently located near you

Bailey Meter Company's sales-service engineers are located in more industrial centers than those of any other manufacturer of boiler control systems; you get prompt, experienced service with a minimum travel-time and expense.

For greater fuel savings, less outage, and safer working conditions you owe it to yourself to investigate Bailey Controls. Ask a Bailey Engineer to arrange a visit to a nearby Bailey installation. We're proud to stand on our record.

A-117-2

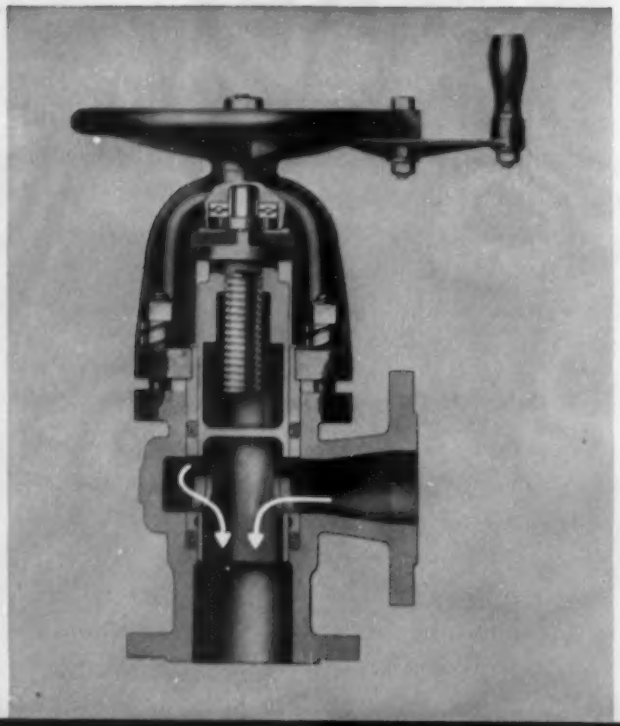
BAILEY
METER COMPANY
1036 IVANHOE ROAD
CLEVELAND 10, OHIO
Complete Controls for Steam Plants

BAILEY METERS
Controls for
COMBUSTION
FEED WATER
TEMPERATURE
PRESSURE
LIQUID LEVEL
FEED PUMPS

These YARWAY VALVE DESIGNS

YARWAY SEATLESS

Features balanced nitralloy hollow plunger that seals line drop-tight, yet permits free, unobstructed flow in blow-down. Other features —laminated packing, alemite lubrication, ball thrust bearings. USED SUCCESSFULLY IN OVER 15,000 BOILER PLANTS.



FOR LOW and MEDIUM PRESSURES

YARWAY HARD-SEAT

Features tough, stellite-faced and ground disc and seat ring, mated to provide smooth long-wearing surfaces. Stream-line flow. Alemite lubrication. MORE THAN 4 OUT OF 5 HIGH PRESSURE BOILER PLANTS USE YARWAY BLOW-OFF VALVES.

FOR HIGHER PRESSURES

USED IN OVER 15,000 BOILER PLANTS

serve every boiler blow-down need

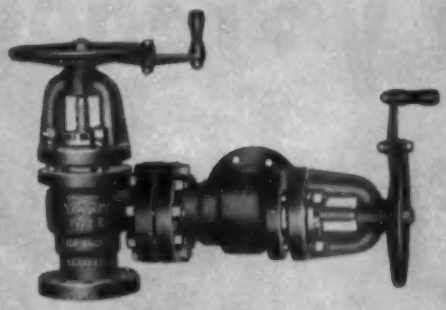
■ Whatever your *pressure* requirement, whatever your *piping* requirement—there's a Yarway Blow-Off Valve to exactly meet your needs.

Popular Yarway *seatless* design keeps blow-down lines drop-tight in low and medium pressure ranges. Sturdy Yarway *stellite seat and disc* design protects higher pressures.

All Yarway Blow-Off Valves are strong, rugged valves, built to withstand the punishment of regular or emergency blowing-down under full boiler pressure, and are available in metals that stand up under acid washing of boilers.

Write for new Yarway Blow-Off Valve Bulletins—B-426 (pressures to 400 psi) or B-434 (pressures to 2500 psi).

• Yarway Type B Seatless Blow-Off Valve, iron body for boiler pressures to 200 psi, steel bodies, for pressures to 400 psi. Angle valve shown, straightway available. Flanged connections. See Bulletin B-426.

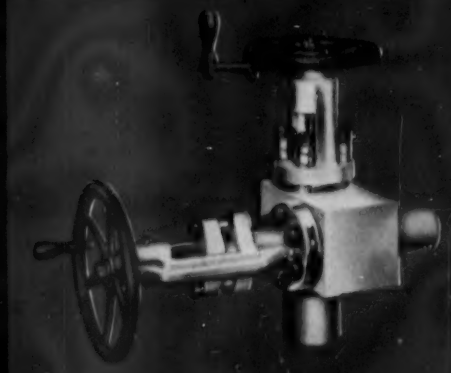


• Yarway Type B Seatless Tandem Blow-Off Valve combining two angle valves. Other combinations available. Iron bodies for boiler pressures to 200 psi, steel bodies for pressures to 400 psi. See Bulletin B-426.

• Yarway Type C Seatless Tandem Blow-Off Valve combining angle and straightway valves. Other combinations available. Flanged or welding connections available. For boiler pressures to 600 psi. NOTE: When used in tandem with a Yarway Hard-Seat Valve, Type C Seatless may be used to 1500 psi. See Bulletin B-434.

• Yarway Hard-Seat Blow-Off Valve For pressures to 2500 psi. Straightway valve shown. Angle available. Welded (shown) or flanged connections. See Bulletin B-434.

• Yarway Hard-Seat—Seatless Tandem Blow-Off Valve. Hard-Seat is the blowing valve, seatless is the sealing valve. Available in any combination of connections. For pressures to 1500 psi. Hard seat-hard seat tandems for pressures to 2500 psi. See Bulletin B-434.



• Yarway Unit Tandem Blow-Off Valve. Combines a hard-seat blowing valve and a seatless sealing valve in one-piece forged steel body for boiler pressures to 1500 psi. For pressures to 2500 psi, two hard-seat valves are combined. See Bulletin B-434.

LET YARWAY HELP SOLVE YOUR BOILER BLOW-DOWN PROBLEMS!

YARNALL-WARING COMPANY
100 Mermaid Avenue, Philadelphia 18, Pa.
BRANCH OFFICES IN PRINCIPAL CITIES

YARWAY

blow-off valves

Only Brown flow meters offer you these profitable "*plus*" *values*

- ***16 different types*** of basic instrument systems . . . a flow meter for every fluid, every pressure, every operating requirement. *You're sure to find the most profitable meter for your specific application.*

- ***Nearby service facilities.*** There's a Honeywell service center as near to you as your phone. Service by factory-trained specialists is prompt, competent and economical. *You're sure to get maintenance and start-up service without delay.*

- ***27 years of experience*** in flow metering development and application work. *You're sure to get specialized engineering on your flow metering problem.*

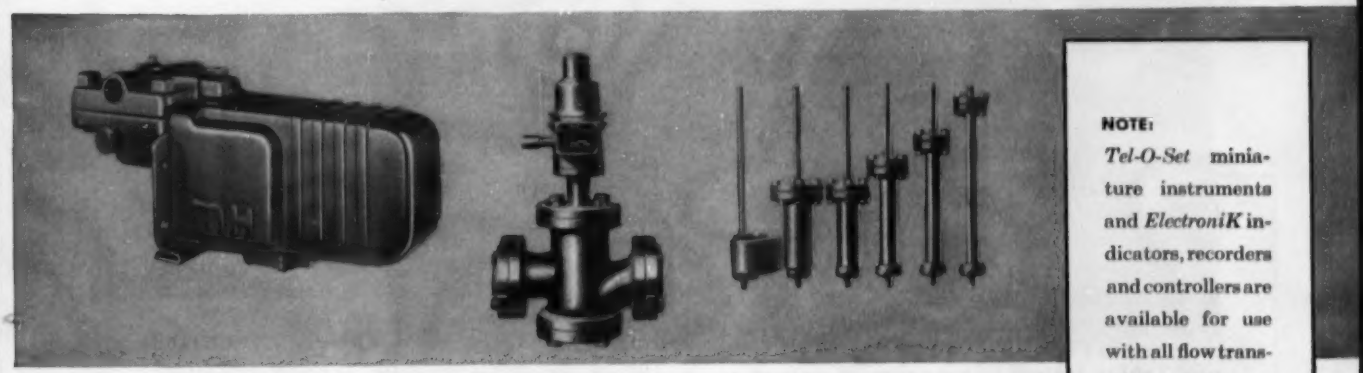
- ***Nationwide field organization.*** Brown flow metering consultation is available from experts in more than 90 field offices, located near every major production center. *You're sure to have application engineering on hand where and when you need it.*

Linear scale meters—mechanical or electrical types, all control forms.

Square root scale meters—mechanical, or electrical or pneumatic transmission . . . all control forms.

Portable meters—versatility, for spot checks of flow values not continuously recorded.

Low pressure meters—either electrical or mechanical type, for air or gas flow.



Differential Converter—mercury-less pneumatic flow transmitter with infinitely adjustable range.

Area Type Meters for measuring flow of viscous fluids . . . electrical transmission.

Interchangeable range tubes typify rangeability of all Brown flow meters.

NOTE:
Tel-O-Set miniature instruments and *ElectroniK* indicators, recorders and controllers are available for use with all flow transmitters.

a flow meter for every fluid...

every application (all available with electronic integration)

In performance, too, Brown flow meters provide you unsurpassed precision . . . reliability . . . convenience . . . with minimum maintenance requirements. In every way, you'll find it pays to select your flow meters from the one line that offers the most value.

Your nearby Honeywell sales engineer will be glad to discuss your specific flow application . . . and he's as near as your phone.

Minneapolis-Honeywell Regulator Co., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.

● **REFERENCE DATA:** Write for new Catalog 2320, "Flow Meters, Indicating, Recording, Integrating, Controlling."

MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS
First in Controls

ELECTRONIC FARROWTEST®

spots defects in welded steel boiler tubes

before you get them

Here's the last word in non-destructive tests for boiler tubes. It's FARROWTEST®, an electronic production method of checking tubing for irregularities.

Republic Steel began developing this test in 1930, now has it available on the production line. You can specify it on ELECTRUNITE Pressure Tubing instead of your present method *at no extra cost.*

HERE'S HOW IT WORKS. Tube to be tested passes through a group of test coils. If the tube is uniform, the signal from the coils stays constant. When an injurious defect in the tube wall shows up, the tube stops moving automatically. An identifying mark is then put on the tube, and it is passed on to the reject rack.

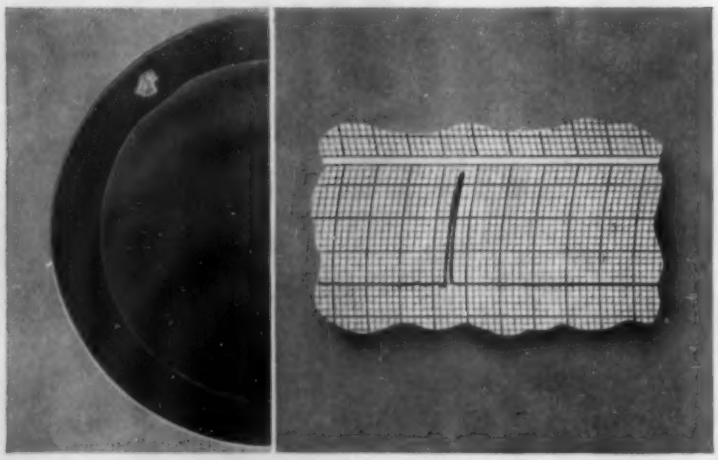
WHAT IT MEANS TO YOU. Many tubing applications require testing beyond the normal non-destructive types. Applications where human life must be protected. Or expensive equipment. Or products. ELECTRUNITE Tubing, made by the electric resistance weld process, is known for its uniformity. Uniform strength, uniform wall thickness, uniform ductility. Add FARROWTEST to these advantages, and you have ELECTRUNITE Tubing that meets the most exacting specifications.

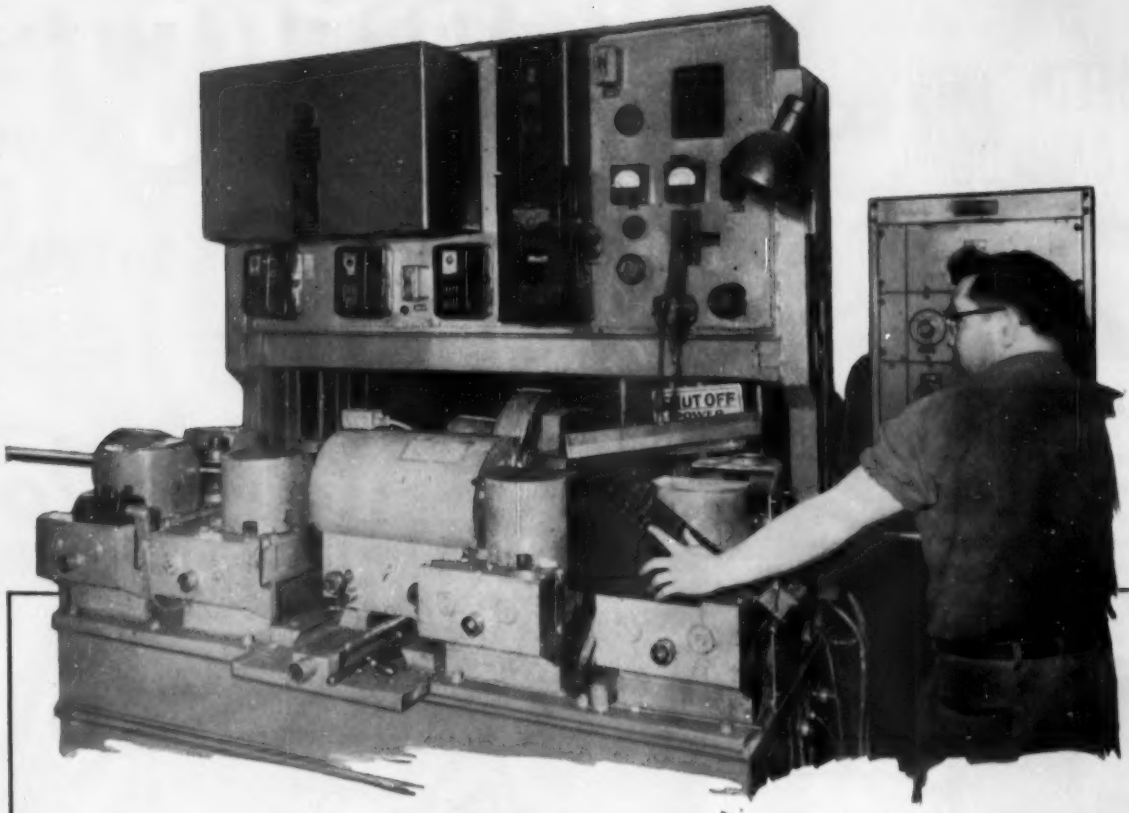
Millions of feet of FARROWTEST tubing have been installed in industrial, marine and utility boilers. And because it's FARROWTESTED, chances are it will stay on the job longer.

When you put in your next order for boiler, heat exchanger or condenser tubes, either carbon or stainless, specify FARROWTEST. *Remember, only Republic Steel offers you this electronic non-destructive test.*

Power plant equipment operating at high pressure creates special window problems. Windows must open and close rapidly to compensate for pressure variations. That's why this station is now equipped with Truscon Donovan Windows.

The FARROWTEST equipment automatically stopped when the defect shown in the micrograph (left below) passed through the detector coils. This defect was charted in the Oscillogram shown on the right.





TESTING METHODS

DESTRUCTIVE TESTING
- FLATTENING TEST
- FLANGE TEST
- EXPANSION TEST
- CRUSH TEST
- REVERSE BEND TEST

All these tests destroy tube. These tests, properly made, eliminate to a very large degree the possibility of large or continuous defects.

NON-DESTRUCTIVE TESTING
- HYDROSTATIC TEST
- AIR TEST
- CO_2 GAS TEST
- FREON GAS TEST

These tests are for the purpose of picking up isolated steel or processing defects. All these methods of testing have some limiting factor as commercially applied.

FARROW TEST

The ultimate available today in electronic, non-destructive testing.

REPUBLIC STEEL

World's Widest Range of Standard Steels and Steel Products

REPUBLIC STEEL

REPUBLIC STEEL CORPORATION
3144 East 45th Street, Cleveland 27, Ohio

Please let me have more information on the following products:

- ☐ FARROWTEST
- ☐ ELECTRUNITE Boiler Tubes
- ☐ Truscon Steel Windows
- ☐ ELECTRUNITE Carbon Steel Heat Exchanger Tubes
- ☐ ELECTRUNITE Stainless Steel Heat Exchanger Tubes

Name_____ Title_____

Company_____

Address_____

City_____ State_____

R-7666

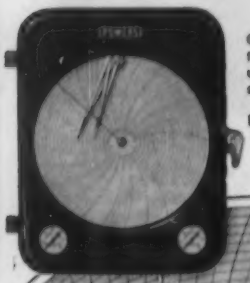
UNITED STATES CAPITOL

Uses **POWERS** System of

AIR CONDITIONING CONTROL

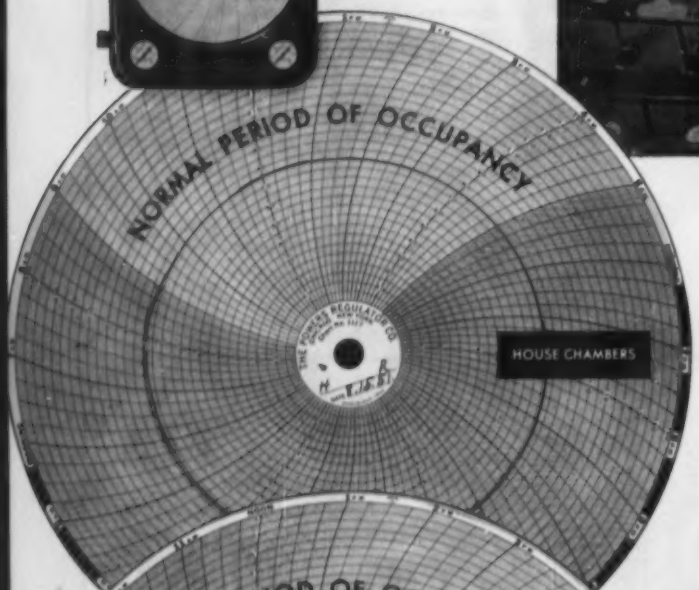
Right: Joint session of the Congress in the recently remodeled House of Representatives—listening to "State of the Union" address by the President.

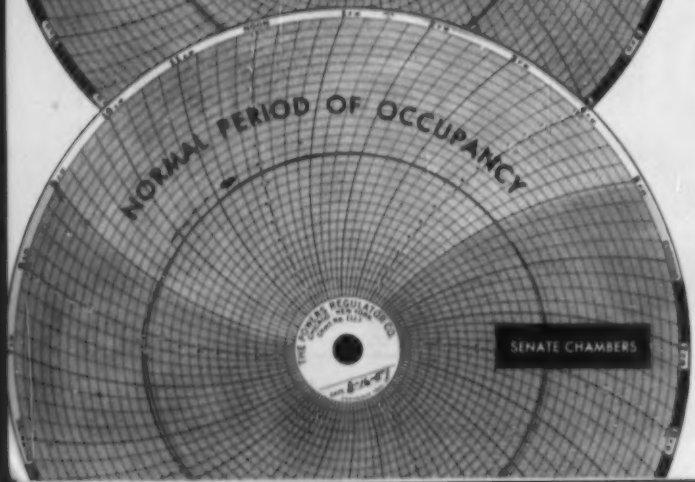
In the historic House and Senate Chambers as well as the administrative offices in the Capitol, heating and air conditioning systems are regulated by a Powers system of pneumatic control.



Only a few of the many types of Powers Control used in the Capitol are shown here.

Left: Powers Two-pen Recording Controller.





World's Largest and Most Comfortable Legislative Hall is Regulated by—

POWERS AIR CONDITIONING CONTROL

◀ Note Accurate Control in House and Senate Chambers

Outdoor temperatures, during the period covered by the temperature charts varied between 75 and 95° F., yet indoor temperature was maintained constant from 9 A.M. to 5 P.M. One temperature sensitive bulb is located near the speaker's rostrum, another is in the gallery. Note separate lines during the off period of control and how the two lines merge into one when Chambers were occupied.

THE POWERS REGULATOR COMPANY

SKOKIE, ILLINOIS

Offices in 60 Cities in U.S.A., Canada, and Mexico • See Your Phone Book

Chicago 13, Ill., 3819 N. Ashland Ave. • New York 17, N.Y., 231 E. 46th Street
Los Angeles 26, Cal., 3200 W. Temple St. • Toronto 15, Ont., P.O. Box 182, Weston
Mexico, D. F., Apartado 63 Bis. • Honolulu 3, H. I., P.O. 2755—450 Piikoi at Kona

OVER 60 YEARS OF AUTOMATIC TEMPERATURE AND HUMIDITY CONTROL

Architect
David Lynn

Consulting Engineer
for Air Conditioning
Charles S. Leopold

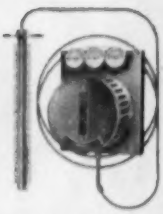
Contractor
Mahring & Hansen Co.

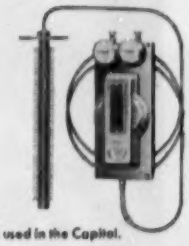
Other Washington Buildings using POWERS Control

Department of Agriculture and Post Office Department Bldgs. • Department of Interior and Old House of Representatives Office Bldgs. • Apex Bldg. • Armed Forces Institute of Pathology, Walter Reed Medical Center • Lafayette Bldg. • Military Component Canadian Embassy Building • Navy Medical Center Bldg. • U.S. Dept. of Health, Education and Welfare Bldg. incl. Voice of America • U.S. Navy Hydrographic Bldg. Washington International Airport.

Experience gained by Powers in supplying dependable temperature and humidity regulation for these buildings may be helpful to you. When your problems involve precise control for heating or air conditioning, contact Powers nearest office . . . in over 60 cities.

Powers Room Type Thermostat

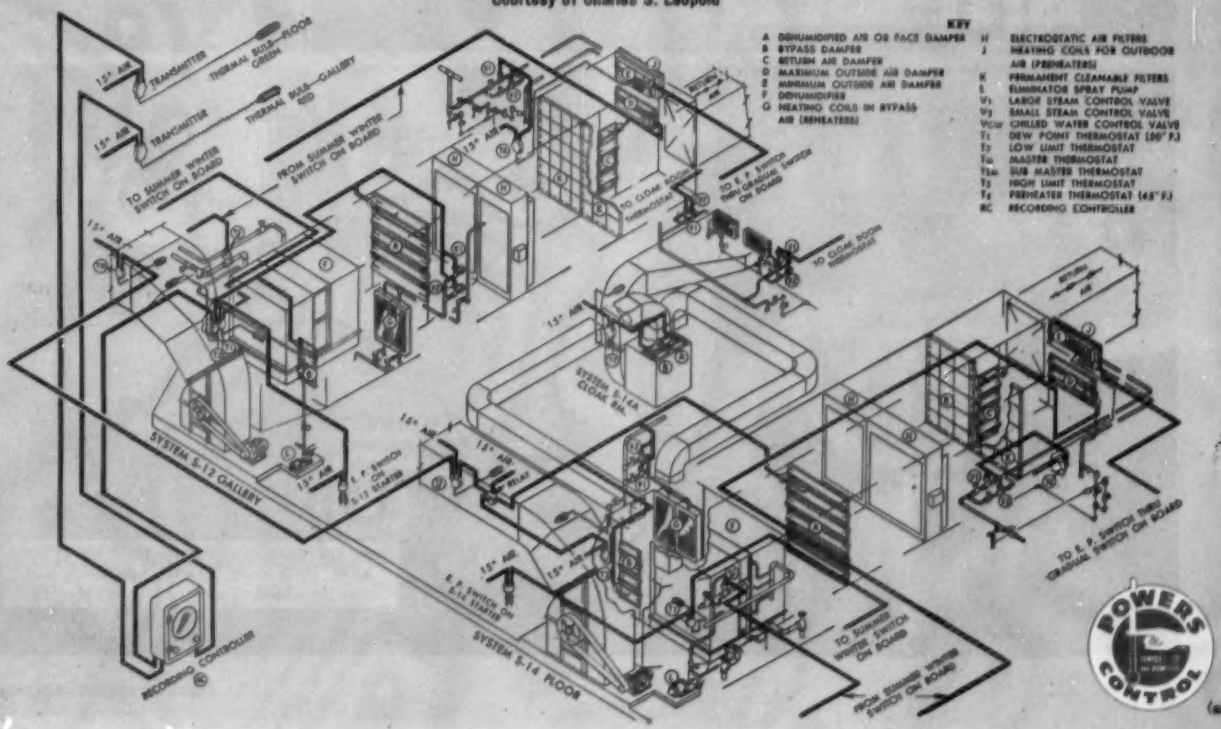




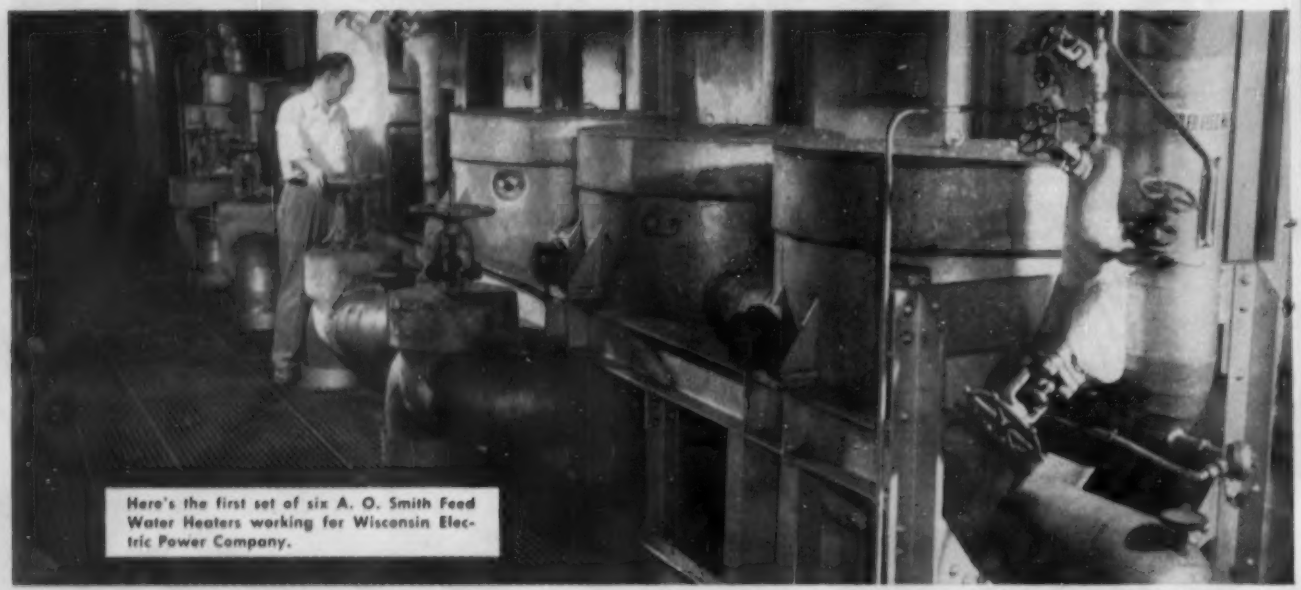
Powers Remote Bulb Thermostats for Dew Point, Low and High Limit, Preheater, Master and Sub-Master Control —only a few of the many controls used in the Capitol.

AIR CONDITIONING APPARATUS DIAGRAM FOR OPERATION AND MAINTENANCE OF SYSTEMS IN THE HOUSE AND SENATE CHAMBERS

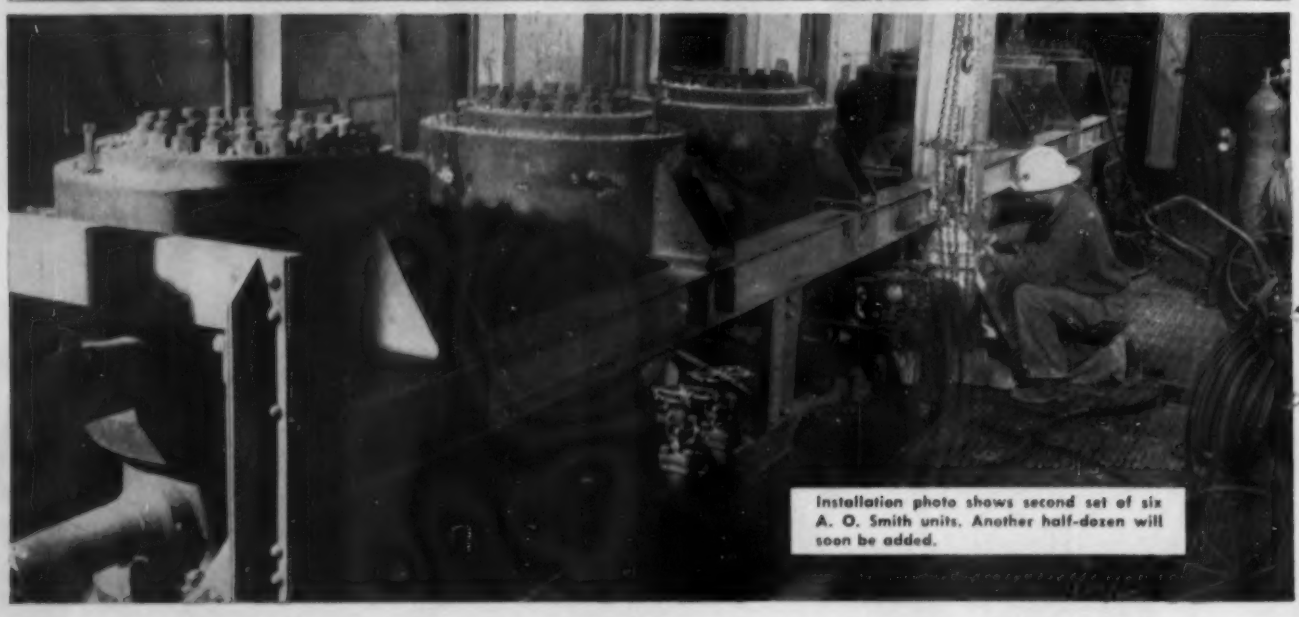
Courtesy of Charles S. Leopold


KEY
A DEHUMIDIFIED AIR OR FACE DAMPER
B BYPASS DAMPER
C RETURN AIR DAMPER
D MAXIMUM OUTSIDE AIR DAMPER
E MINIMUM OUTSIDE AIR DAMPER
F DEHUMIDIFIER
G HEATING COILS IN BYPASS AIR (REHEATERS)
H ELECTROSTATIC AIR FILTERS
J HEATING COILS FOR OUTDOOR AIR (PREHEATERS)
K PERMANENT CLEANABLE FILTERS
L ELIMINATOR SPRAY PUMP
V1 LARGE STEAM CONTROL VALVE
V2 SMALL STEAM CONTROL VALVE
VCW CHILLED WATER CONTROL VALVE
T1 DEW POINT THERMOSTAT (50° F.)
T2 LOW LIMIT THERMOSTAT
TM MASTER THERMOSTAT
TSM SUB MASTER THERMOSTAT
T3 HIGH LIMIT THERMOSTAT
T4 PREHEATER THERMOSTAT (45° F.)
RC RECORDING CONTROLLER
15° AIR
TRANSMITTER
THERMAL BULB—FLOOR GREEN
THERMAL BULB—GALLERY RED
TO SUMMER WINTER SWITCH ON BOARD
FROM SUMMER WINTER SWITCH ON BOARD
TO GLOBE ROOM THERMOSTAT
TO E. P. SWITCH THRU CRASHING SWITCH ON BOARD
SYSTEM S-12 GALLERY
SYSTEM S-14A GLOBE RM.
SYSTEM S-14 FLOOR
RECORDING CONTROLLER
POWERS CONTROL

Third set of A. O. Smith Feed Water Heaters ordered by Wisconsin Electric Power Company



Here's the first set of six A. O. Smith Feed Water Heaters working for Wisconsin Electric Power Company.



Installation photo shows second set of six A. O. Smith units. Another half-dozen will soon be added.

The Oak Creek plant, pictured here, is located on the shores of Lake Michigan near Milwaukee.

A. O. SMITH is proud to be associated with Wisconsin Electric Power Company's Oak Creek plant — Wisconsin's largest. The new features designed into these steam turbine generator units make it one of the country's most modern plants.

Now on the job at Oak Creek are two sets of six A. O. Smith Feed Water Heaters. These will soon be augmented by another bank of six . . . each bank designed with desuperheating and drain cooling sections.

These A. O. Smith units are built for operating pressures of 2,400-2500 psi. End closure and channel test out at 4,800 psi. Inside diameter is 24 inches, while overall lengths are up to 23 feet.

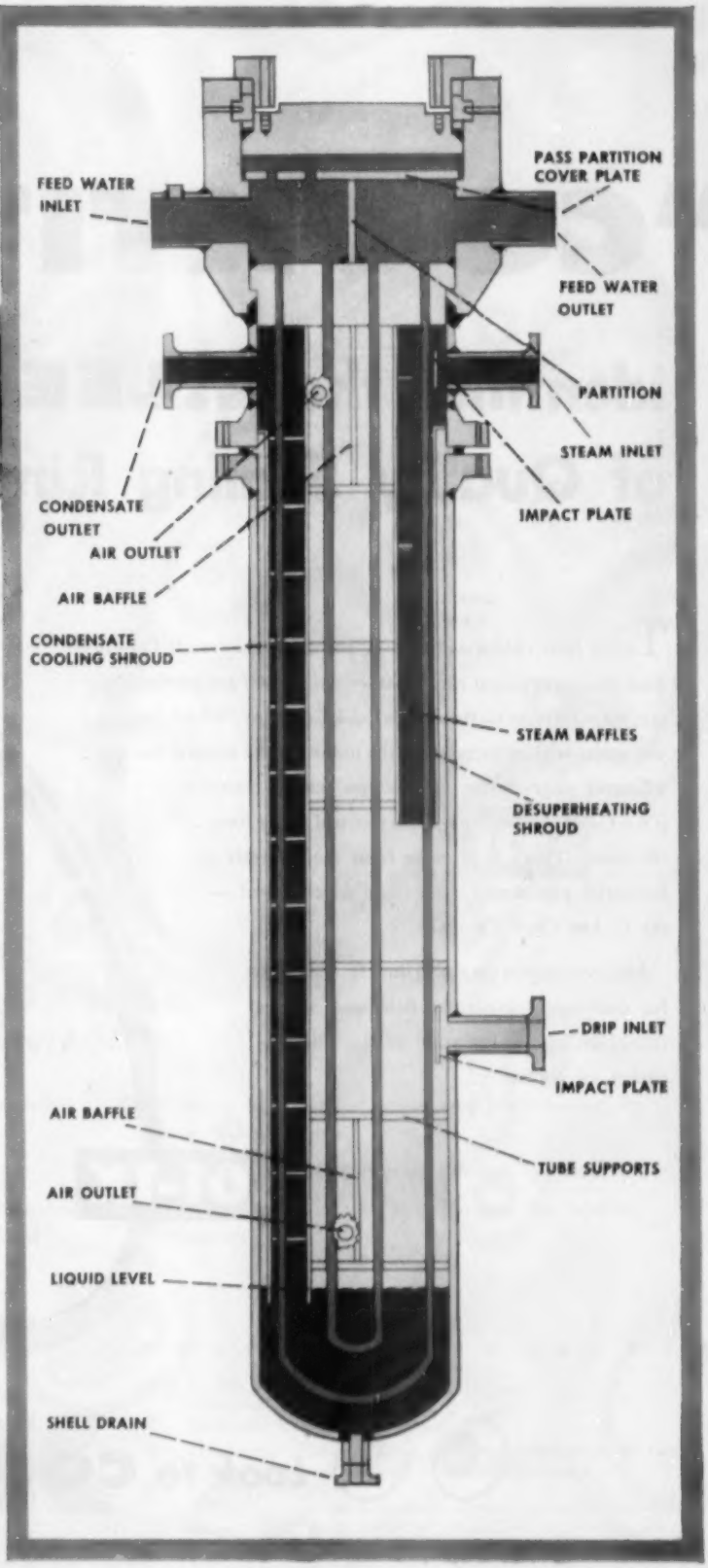
Exchanger designs, proved through years of service, make specifications of 1,000 to 10,000 psi *standard* in our exchanger and vessel shops. *Special* heat transfer problems, too, can be solved best by A. O. Smith, because our thermal design group is recognized as one of the finest in the country. You'll profit most by contacting A. O. Smith first.

Through research ...*a better way*

A.O.Smith

CORPORATION

PROCESS EQUIPMENT DIVISION
Milwaukee 1, Wisconsin
International Division: Milwaukee 1



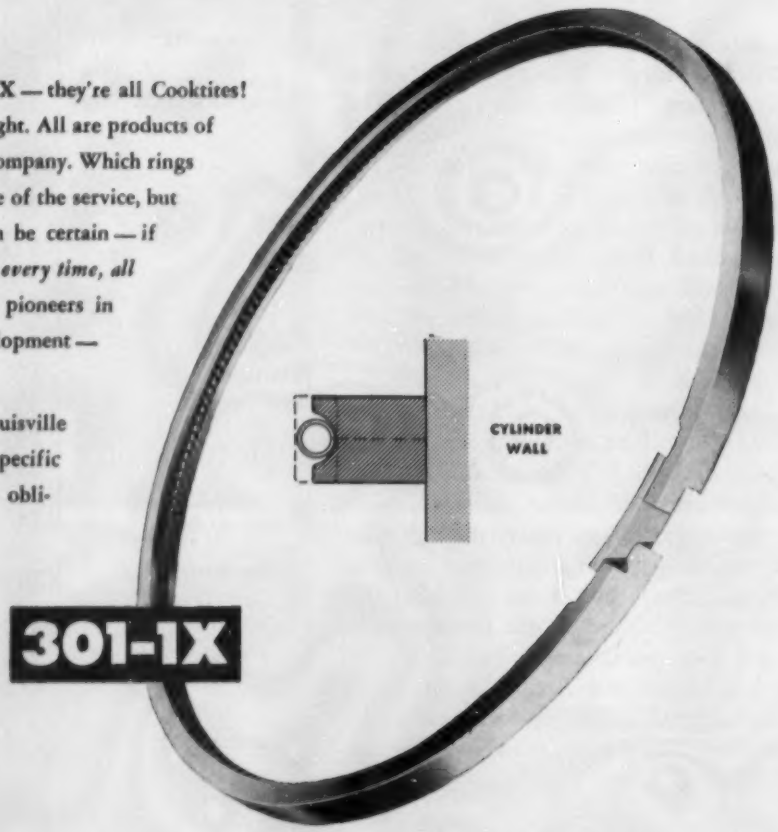
Cutaway drawing shows a Feed Water Heater of the type used by Wisconsin Electric Power Company.

"COOKTITE"

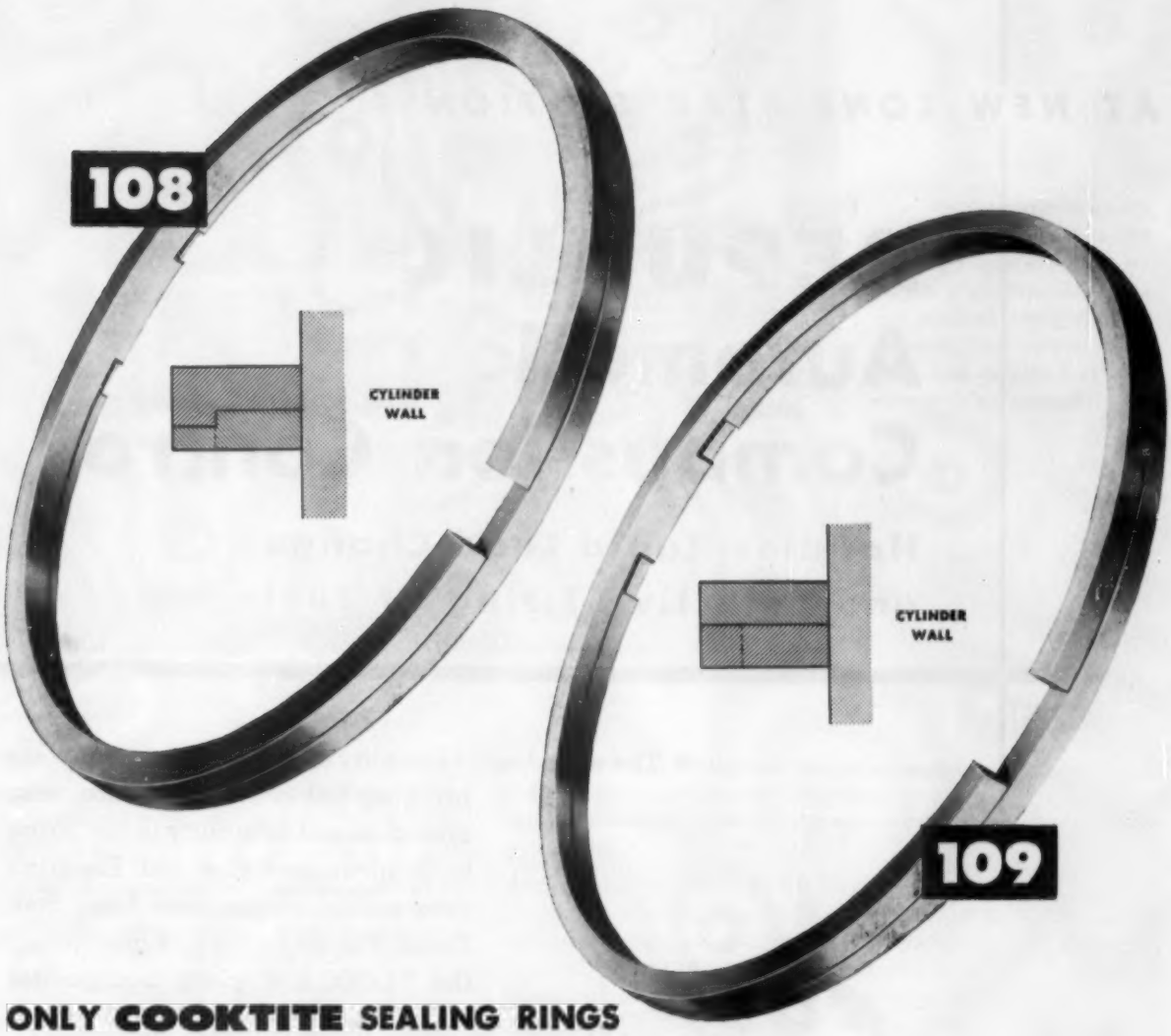
identifies the C. LEE COOK family of Quality Sealing Rings!

TAKE your choice — 108, 109, 301-1X — they're all Cooktites! Each is a great piston ring in its own right. All are products of one manufacturer — the C. Lee Cook Company. Which rings you select will be dictated by the nature of the service, but whatever your choice, of this you can be certain — if it's a Cooktite you'll get a perfect seal *every time, all the time.* That's a promise from the pioneers in industrial piston ring design and development — the C. Lee Cook Company.

Mail the coupon (at right) direct to Louisville for complete engineering data, and specific recommendations for your units. No obligation, of course!



Look to COOK for Better Rings!



ONLY COOKTITE SEALING RINGS GIVE YOU ALL THESE ADVANTAGES!

- Insure perfect cylinder seal, thereby preventing blow-by which destroys lubricating oil film!
- Decrease rate of cylinder wear!
- Have special joint construction which eliminates compression leak characteristic of plain rings!
- Restore new engine power and performance to worn cylinders!
- Reduce fuel consumption in tapered cylinders!
- Assure long effective ring life due to superior materials!

C. LEE COOK COMPANY

Sealing Pressures Since 1888

C. Lee Cook Company
950 South 8th Street
Louisville 3, Kentucky

Gentlemen: Please send me complete information on Cook Piston Rings and name of nearest representative.

Firm_____

Street_____

City_____ State_____

Attention:_____

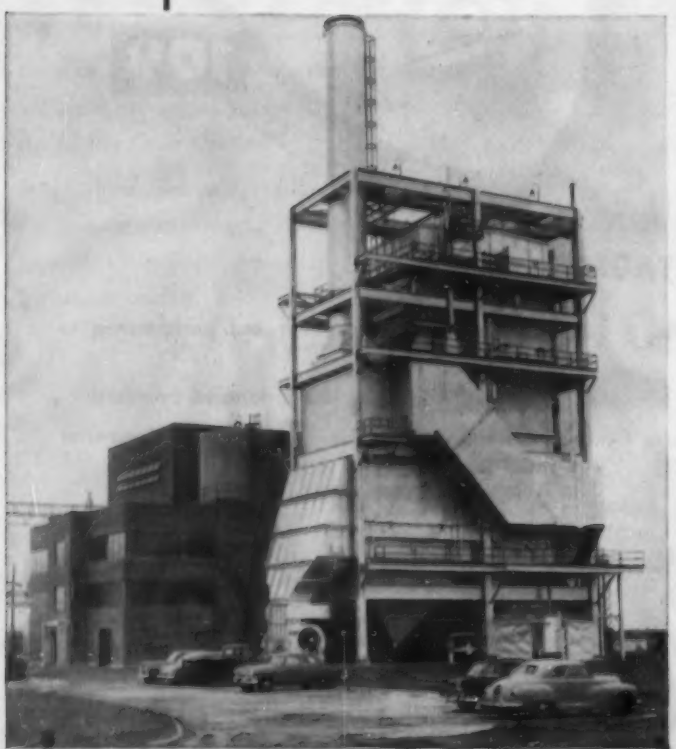
Type of Units_____

AT NEW LONE STAR STATION

REPUBLIC Automatic Combustion Control

Handles Rapid Load Changes and Selective Firing of Fuels

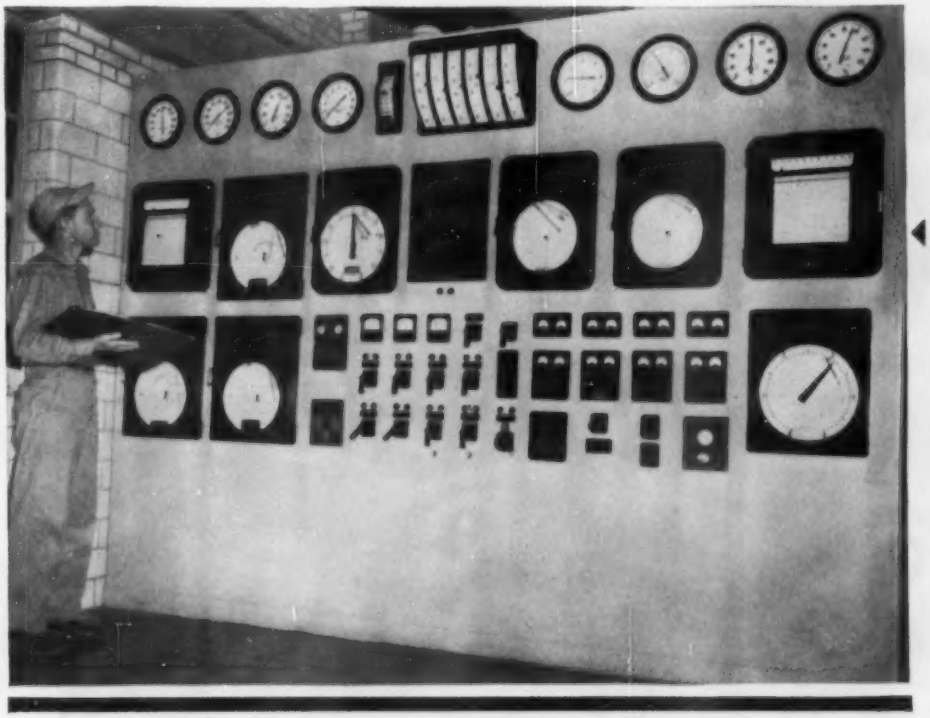
● The speed and versatility of modern electronics are bringing fast control response, easy operation and flexibility in fuel firing to Southwestern Gas and Electric's new central station near Lone Star, Texas. Placed on the line this spring, the 54,000 KW plant incorporates many of the latest ideas in power plant design, including a Republic Automatic Combustion Control System with Telemaster Electronic master control.



Lone Star Station, Lone Star, Texas
Southwestern Gas and Electric Company
Sargent and Lundy, Engineers

Steam generator is the outdoor type with a pressurized furnace. It is designed for maximum steam output of 470,000 lbs. per hour at 920 psig and 910° F. at the superheater outlet.

REPUBLIC FLOW METERS CO.



Electronic master controls at this panel provide for either steam pressure or steam pressure-load control, manual setting of fuel-air ratio, fuel valves, draft fans, and selection of one of four firing methods.

The plant is arranged to fire both natural and coke oven gas. Automatic fuel selector controls provide for four firing combinations:

#1 Automatic preferential control of coke oven gas in accordance with its availability, with sequential make-up of natural gas.

#2 Manual control of the coke oven gas proportion, with sequential make-up of natural gas.

#3 Block or adjusted constant flow of natural gas with coke oven gas make-up.

#4 Block, or adjusted constant flow of coke oven gas, with natural gas make-up.

Extremely fast load changes are common at the Lone Star plant. Immediate control response is possible, however, because the system uses a new type load control to get the earliest indication of a load change and provide the initial impulse for controlling fuel and air to the boiler. Electronic impulses to positioners and regulators eliminate transmission lags—enable control equipment to make immediate compensations for changing loads. Steam pressure control is also possible if desired.

According to Mr. John Turk, Chief Engineer, the electronic control system is extremely simple to operate. Operators regularly run the plant on automatic between maximum capability and a minimum load of 15,000 KW, although wide range automatic operation was not planned when the control system was designed. The three-element Republic feedwater control in the plant is left on automatic to essentially zero load.

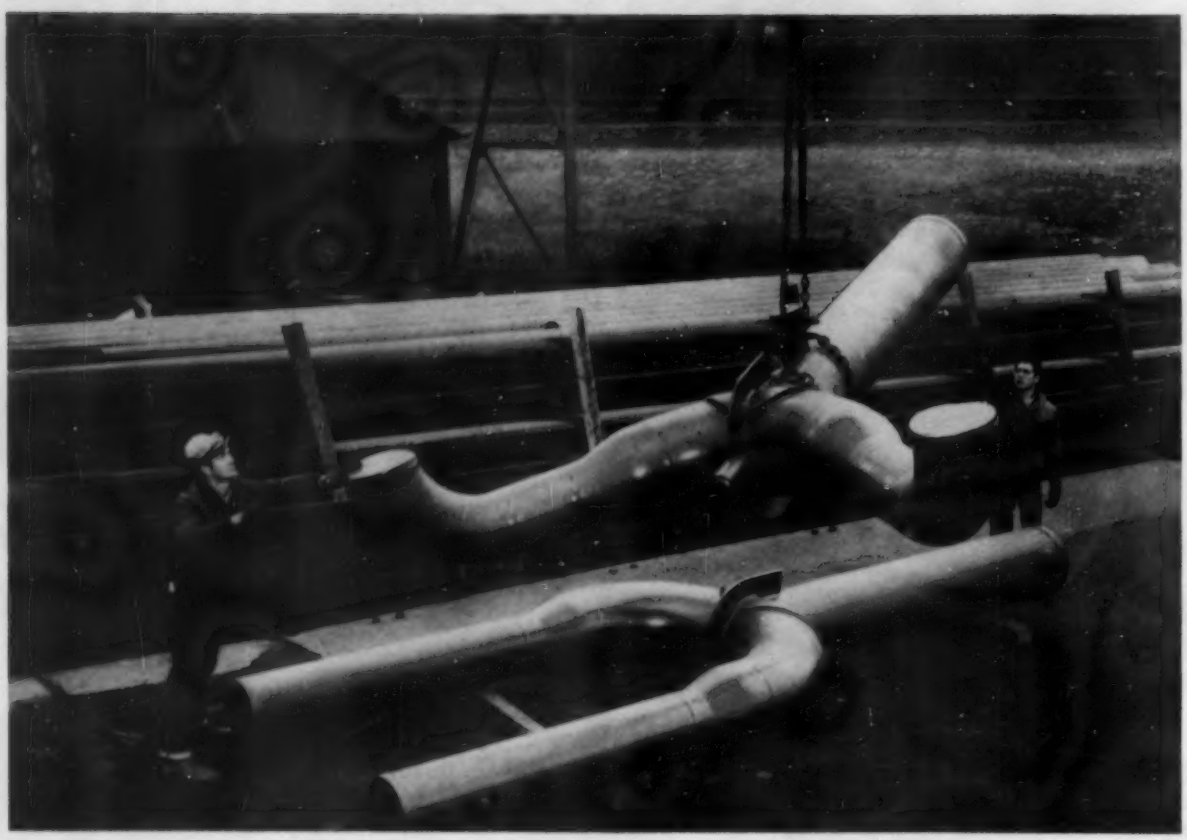
For more complete details about Republic Combustion Controls, write for Data Book.

●

Republic brings you the latest features in Automatic Combustion Controls

★ For all types and sizes of boilers
★ For all arrangements of draft
★ For all types of fuel firing
★ For all load conditions

2240 Diversey Parkway • Chicago 47, Illinois



1000° hot reheat mixing chamber ...ready for shipment to Plant Hammond

This large complicated 1¼% chrome, ½% molybdenum assembly . . . completely shop fabricated by the Power Piping Division of Blaw-Knox . . . is the third unit to be shipped to Georgia Power's 300,000-kw Plant Hammond at Rome, Georgia.

It's the complex type of job that would be practically impossible to assemble in the field. For instance, it required the most modern shop facilities, as well as great skill, in the fitting and welding of the large reinforced special nozzle well . . . to insure perfect alignment and prevent distortion.

When installed, this unit will be a vital part of a power piping system which will consist of 250,000 feet of pipe, ranging in size from ¼ inch to 24 inches. Sizes 2½ inches and larger were shop fabricated . . . smaller sizes were field fabricated.

This entire system is being fabricated and erected by Blaw-Knox . . . the kind of service which is readily available to you through our Power Piping Division.

Just tell us your requirements and we'll provide the service you need.

BLAW-KNOX COMPANY
Power Piping and Sprinkler Division
Pittsburgh 33, Pennsylvania

BLAW-KNOX

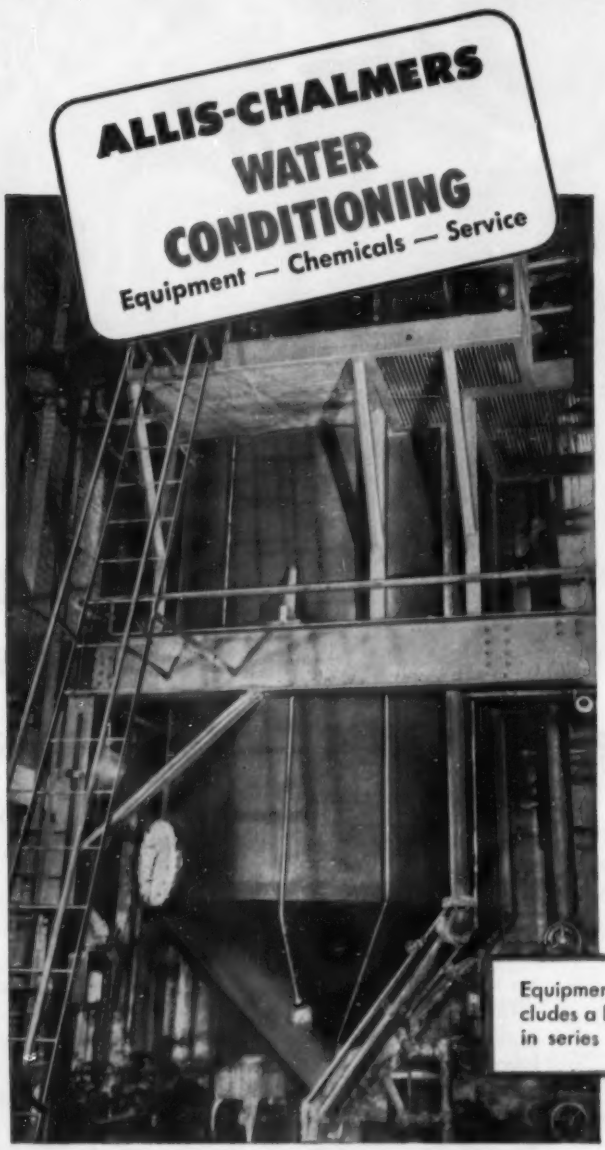
POWER PIPING

To get more information on piping for industry, write for your copy of Bulletin No. 2443.

Complete prefabricated piping systems for all pressures and temperatures . . . plus complete line of functional spring hangers constant support spring hangers • rigid hanger assemblies • overhead roller assemblies • supports • vibration eliminators

Minneapolis Gas Co., Minneapolis, Minn., Gets...

MORE BOILER FEEDWATER



How to increase feedwater supply without adding excessively to chemical and equipment costs? That was the problem at Minneapolis Gas Company, Minneapolis, Minn., when installation of new equipment increased demands on the power plant.

Allis-Chalmers water conditioning engineers solved this problem with a hot lime, ion exchange system that provides zero hardness, extremely low silica content, low alkalinity and low CO_2 in steam. Chemical costs are very reasonable, since only salt and lime are needed. An added dividend can come from the small amount of space required for equipment — for example, in one installation of this type, the resin tanks are tucked under the basement stairs.

Solve Any Water Problem

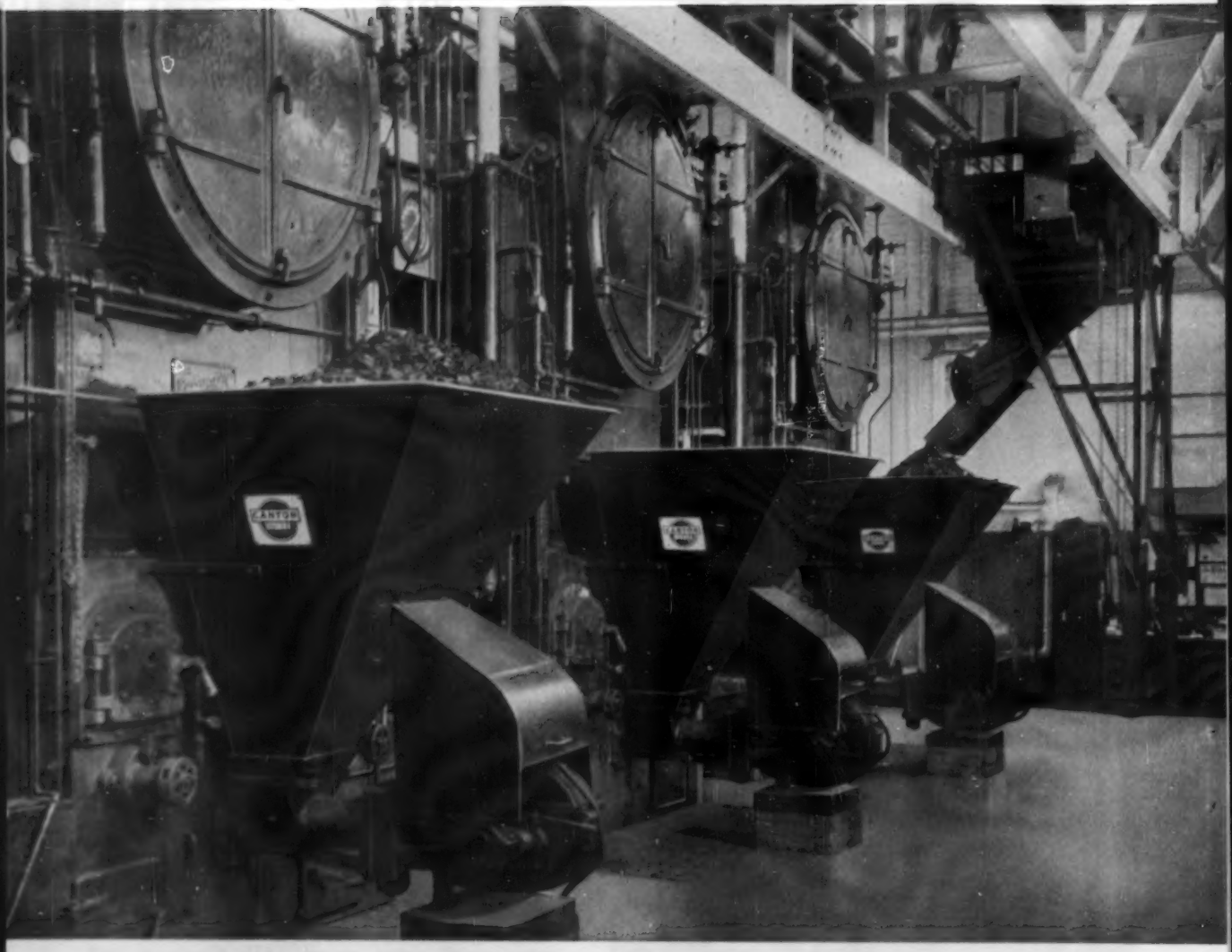
You can find a solution to any water conditioning problem by consulting with an Allis-Chalmers water conditioning expert. Allis-Chalmers will provide analysis and a complete recommendation, in addition to supplying you with the chemicals and equipment you need.

If you would like to learn more about the hot lime, ion exchange process outlined above, get a copy of Allis-Chalmers Water Conditioning Informational Bulletin 49 from your nearby A-C district office, or write Allis-Chalmers, Milwaukee 1, Wisconsin.

A-4403

Equipment similar to this at Minneapolis Gas Co. includes a hot process lime-soda softener which is placed in series with the hot zeolite (ion exchange) unit.

ALLIS-CHALMERS



Burning coal the modern way saves Lakewood Hospital 22% in fuel costs

When Lakewood Hospital, Lakewood, Ohio, recently enlarged its facilities, the hospital authorities decided to install a new boiler plant. After careful consideration, they chose coal.

Today the hospital's automatic coal-burning equipment supplies steam at high efficiency to laundry, kitchen, sterilizers and heating system. The coal is handled and burned cleanly, meeting rigid sanitary requirements. And, based on local rates, coal costs $4,068 less per year than natural gas and $6,348 less than oil! Using the lower figure, burning coal the modern way has effected a 22% savings in fuel costs.

Investigate Your Fuel Costs

If you're planning to modernize your plant or build a new one—or if you are just interested in cutting fuel costs—find out how coal, burned the modern way, compares to other fuels. Talk to a consulting engineer or your nearest coal distributor. Their advice may save you thousands of dollars every year.

facts you should know about coal

In most industrial areas, bituminous coal is the lowest-cost fuel available.

Up-to-date coal burning equipment can give you 10% to 40% more steam per dollar.

Automatic coal and ash handling systems can cut your labor cost to a minimum.

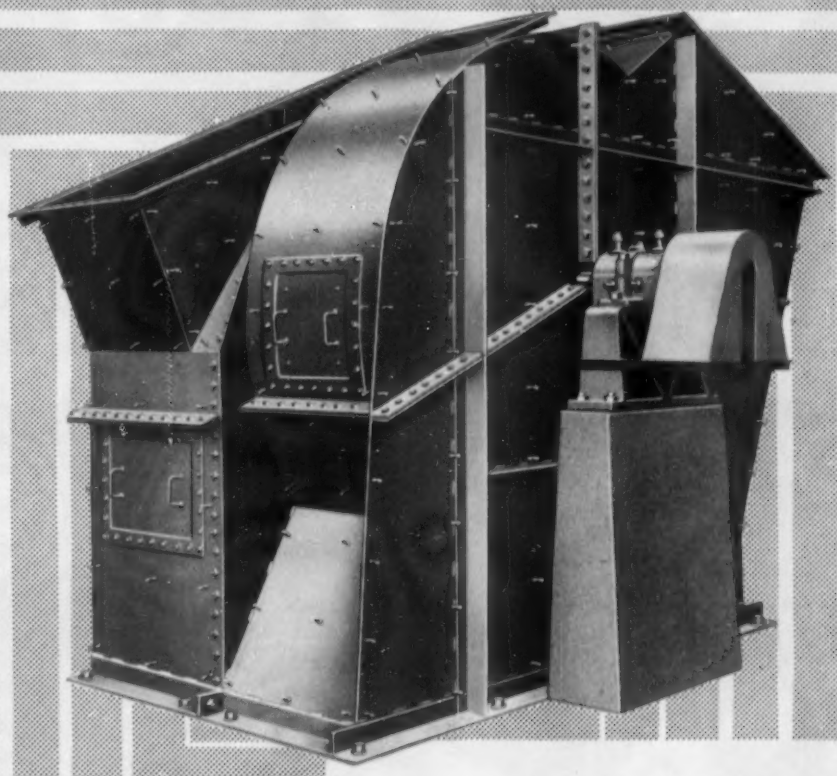
Coal is the safest fuel to store and use. No dust or smoke problems when coal is burned with modern equipment.

Between America's vast coal reserves and mechanized coal production methods, you can count on coal being plentiful and its price remaining stable.

For further information or additional case histories showing how other plants have saved money burning coal, write to the address below.

BITUMINOUS COAL INSTITUTE
A Department of National Coal Association
Southern Building, Washington 5, D.C.

Over 3000 power plants are Clarage equipped



With mechanical draft fans especially, first cost is not the major consideration. Economy is measured by your investment over the long pull.

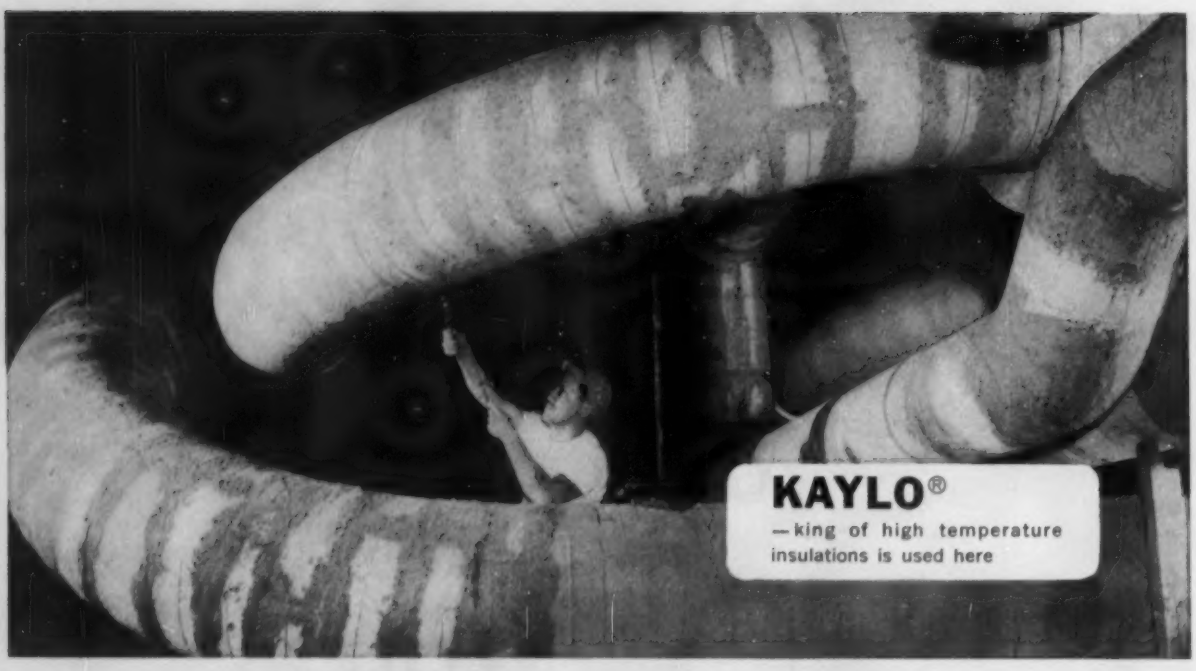
That's why Clarage fans enjoy such a high standing in power production. Here's equipment designed and constructed to take punishment in stride. Wheels, shafts, housings, bearings — all are built **above and beyond** the demands of average service.

You can install Clarage equipment with confidence that operating and maintenance costs will be at an absolute minimum. Hundreds of Clarage fans in continuous service for 30 years and longer testify to that!

Have us put the facts in your hands. Request catalogs on Clarage Type RT induced and forced draft fans . . . Type W, Classes III and IV forced draft fans . . . Type NH, Class II-A forced draft fans. **CLARAGE FAN COMPANY, Kalamazoo, Michigan.**

YOU CAN RELY ON **CLARAGE**

SALES ENGINEERING OFFICES IN ALL PRINCIPAL CITIES • IN CANADA: Canada Fans, Ltd., 4285 Richelieu St., Montreal



THEY ANSWER ALL YOUR INSULATION NEEDS!

Kaylo and Fiberglas* are outstanding in thermal efficiency. They offer the most complete and versatile line of plant insulations available, ranging from lowest subzero to 1200° F. They are exceptionally strong—moisture-resistant—dimensionally stable—light in weight and easy to apply. They can even be used again after removal for pipe inspection! (Kaylo is now distributed by Owens-Corning and is available in quantity.) For full technical data about Kaylo and Fiberglas insulations see Sweet's File, Chemical Engineering Catalog or Refinery Catalog. Or write: Owens-Corning Fiberglas Corporation, Dept. 186-B, Toledo 1, Ohio.

OWENS-CORNING
FIBERGLAS

*T.M. Reg. by Owens-Corning Fiberglas Corporation

HYDROGEN COOLING SYSTEMS INCREASE THE EFFICIENCY of these two 20,000 kw G-E turbine-generators at Lake Superior District Power Company, Ashland, Wisconsin. Reading is being taken at the control panel.

Higher efficiency of G-E hydrogen cooling system lowers turbine-generator fuel costs

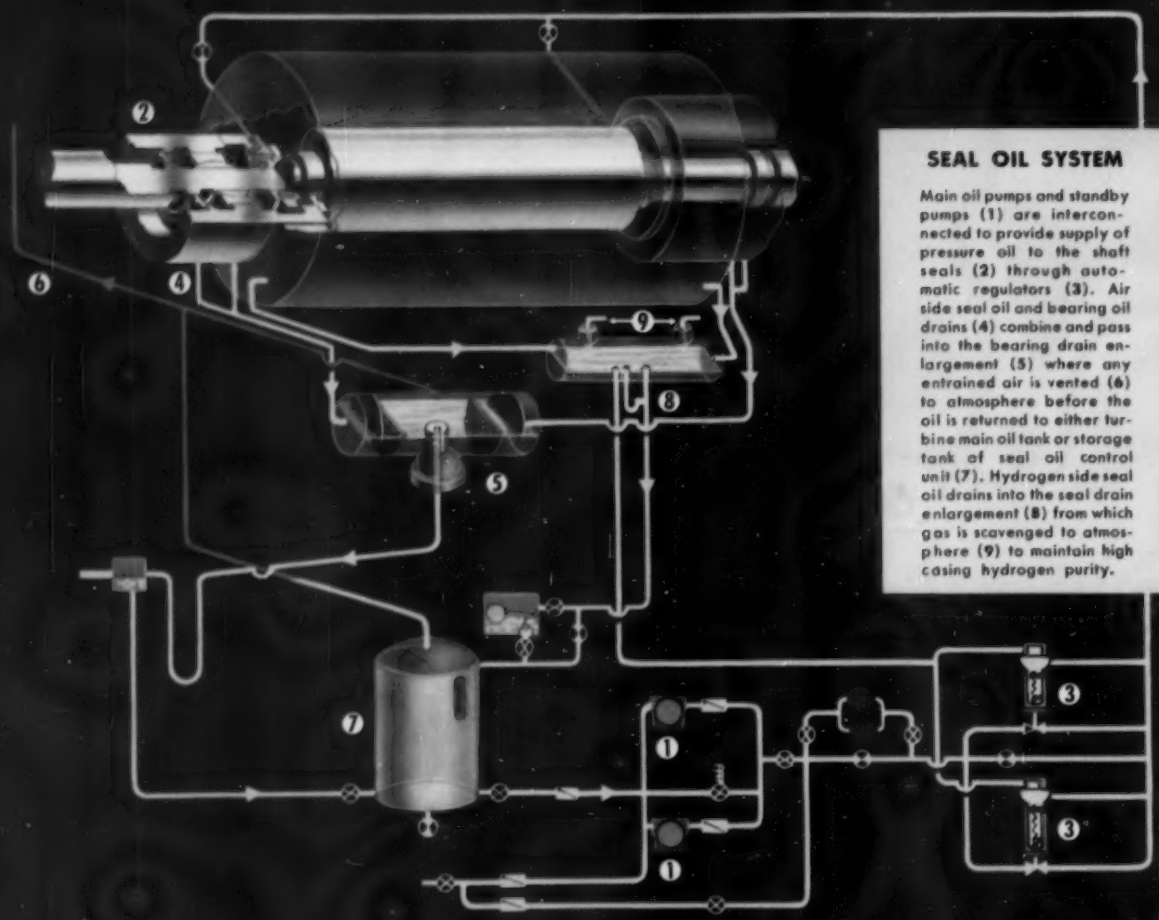
On General Electric turbine-generators in the size range of 15,000 to 40,000 kw, hydrogen cooling can provide full load efficiency from ½ to 1 per cent better than air-cooled machines of equivalent ratings. Thus, the benefits of hydrogen cooling, which for years has been built into larger-size G-E generators, can mean substantial annual fuel savings for users of machines in this medium size range.

Hydrogen cooling offers lower losses, cleaner ventilating passages, and minimum corona effect on windings. Fire hazard is less than for an air-cooled machine because commercially pure hydrogen will not support combustion. Superior heat transfer makes for smaller size and weight. The G-E system maintains high hydrogen purity with consumption of hydrogen kept to about 50 per cent of other systems now in use.

Details of this proven G-E hydrogen cooling system are described on the next three pages.

GENERAL ELECTRIC

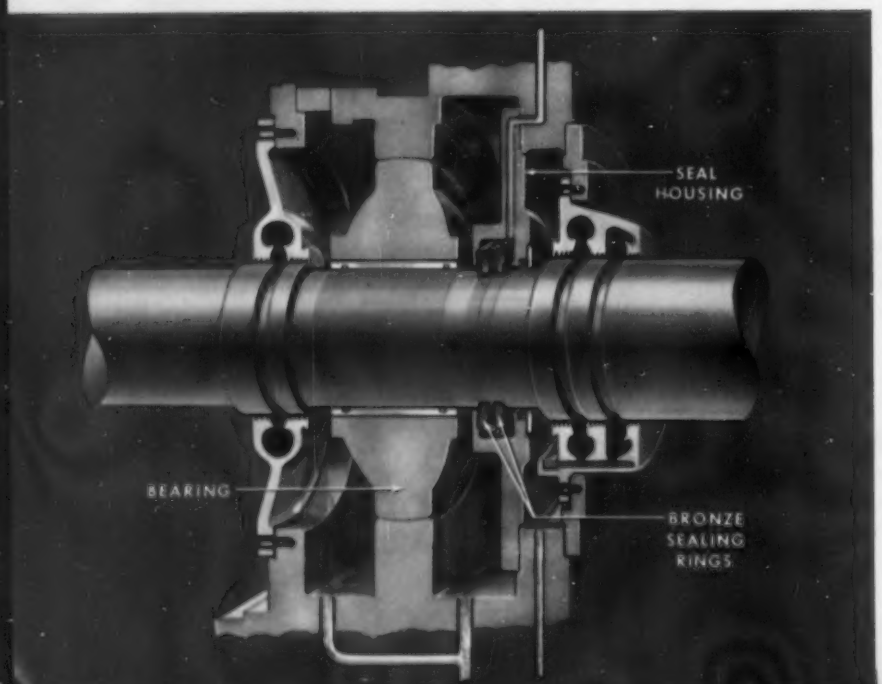
For Details Turn To Following Pages . . .



SEAL OIL SYSTEM

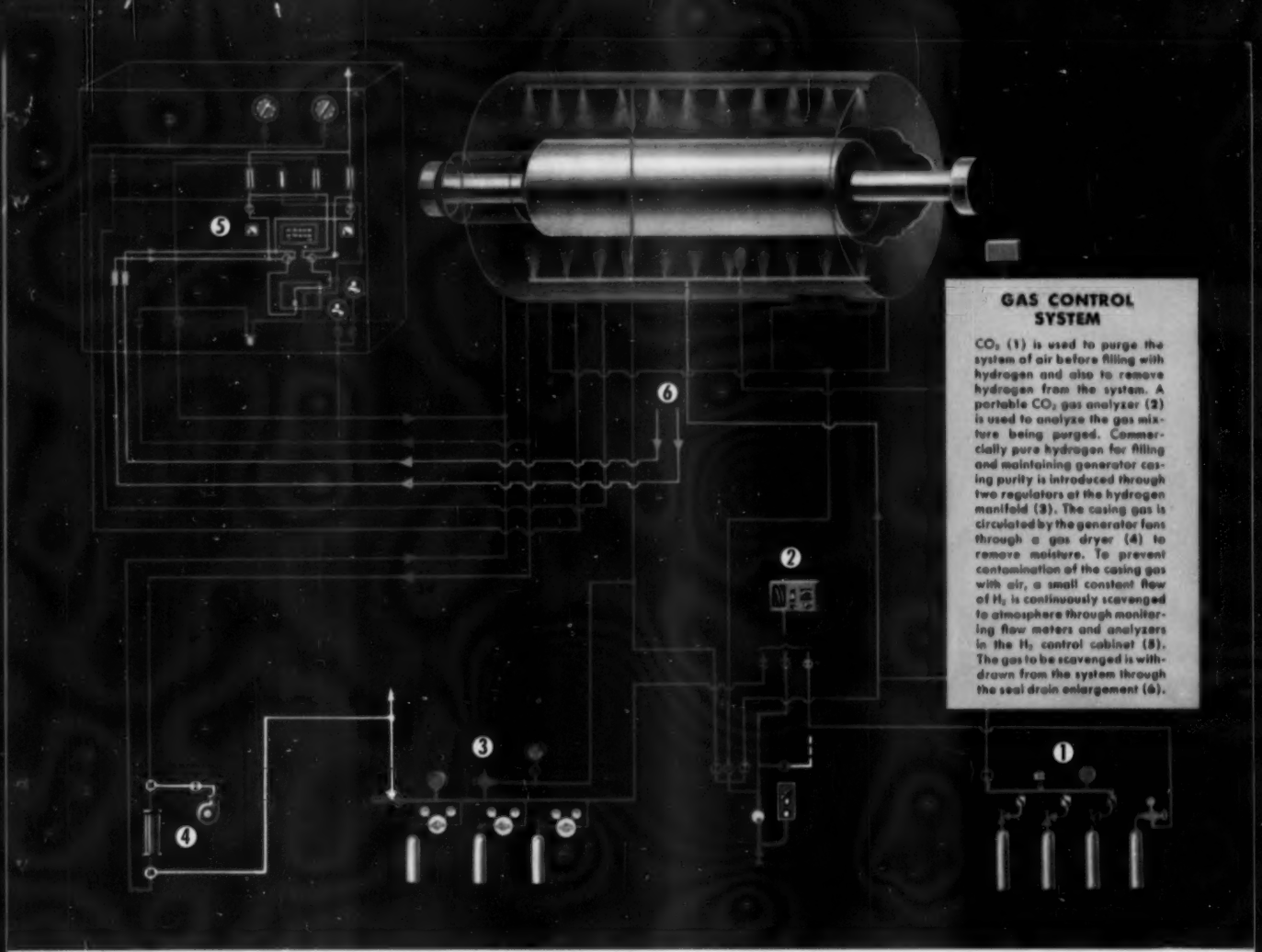
Main oil pumps and standby pumps (1) are interconnected to provide supply of pressure oil to the shaft seals (2) through automatic regulators (3). Air side seal oil and bearing oil drains (4) combine and pass into the bearing drain enlargement (5) where any entrained air is vented (6) to atmosphere before the oil is returned to either turbine main oil tank or storage tank of seal oil control unit (7). Hydrogen side seal oil drains into the seal drain enlargement (8) from which gas is scavenged to atmosphere (9) to maintain high casing hydrogen purity.

Gas stays in, air stays out for high purity



SEAL ASSEMBLY

A seal at each end of the generator prevents the escape of hydrogen from the casing along the rotor shaft. The seal, which is supported from the outer end shield, consists of a pair of bronze *sealing rings* with an internal diameter just a few thousandths of an inch larger than the shaft diameter. Oil at a pressure of about 5 psi above the hydrogen pressure in the casing is supplied to the *seal housing* and enters the annular space between the sealing rings. It flows in both directions between the sealing rings and the shaft, preventing the loss of gas. The *bearing* is entirely external and separated from the shaft seal and may be inspected without removing the gas from the generator.



GAS CONTROL SYSTEM

CO_2 (1) is used to purge the system of air before filling with hydrogen and also to remove hydrogen from the system. A portable CO_2 gas analyzer (2) is used to analyze the gas mixture being purged. Commercially pure hydrogen for filling and maintaining generator casing purity is introduced through two regulators at the hydrogen manifold (3). The casing gas is circulated by the generator fans through a gas dryer (4) to remove moisture. To prevent contamination of the casing gas with air, a small constant flow of H_2 is continuously scavenged to atmosphere through monitoring flow meters and analyzers in the H_2 control cabinet (5). The gas to be scavenged is withdrawn from the system through the seal drain enlargement (6).

and minimum hydrogen consumption

On many recent General Electric hydrogen cooled generators, casing gas purity has been maintained above 99 per cent, with hydrogen consumption as low as 35 cubic feet per day at 15 lb. pressure.

Here's how G-E turbine-generators achieve this performance: The seal assemblies at each end of the generator shaft are fitted so closely that very little oil is required to completely seal off the inside of the generator. Result: Almost no contaminating air is carried into the generator by the seal oil.

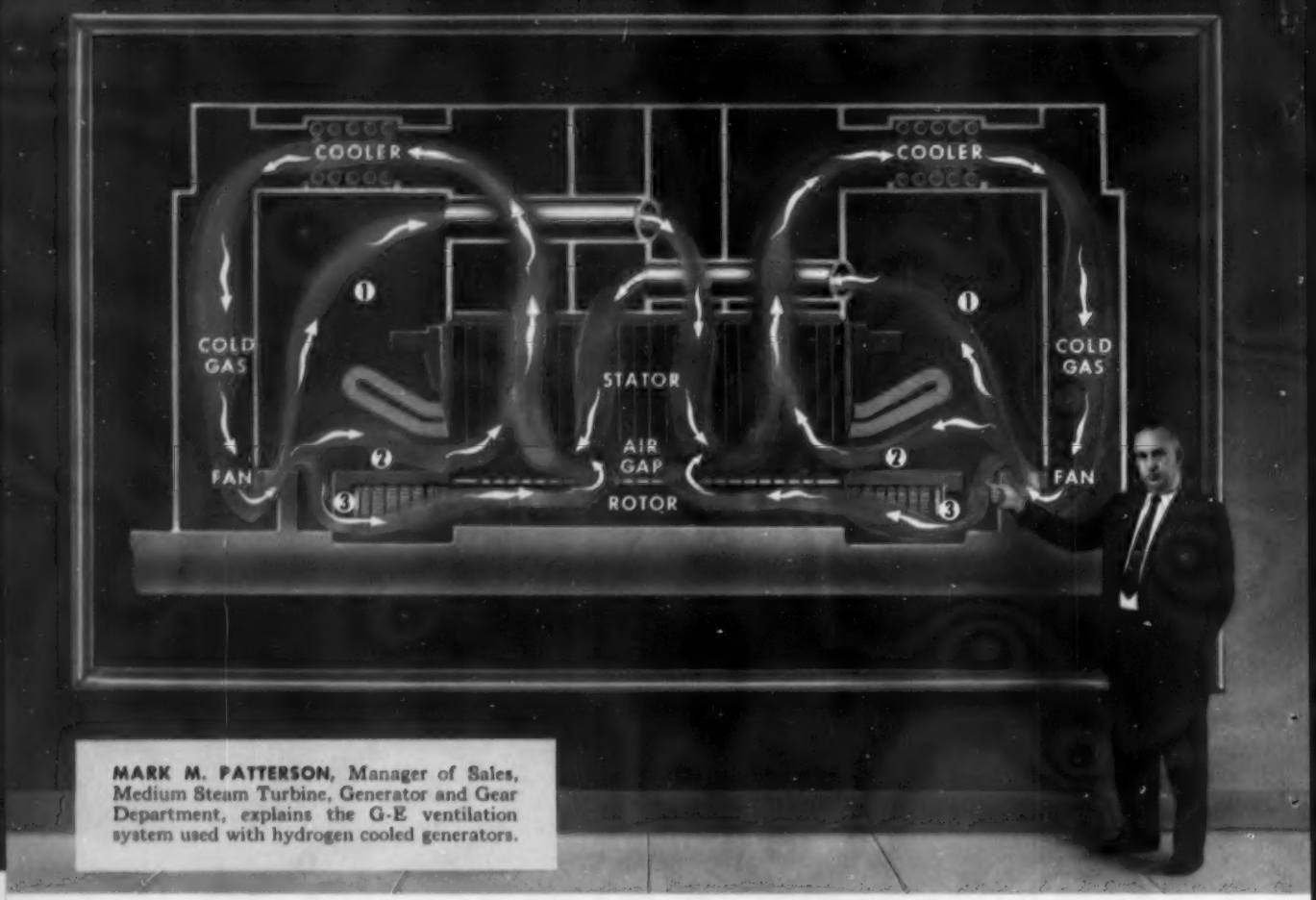
Further, a system of gas detrainers constantly and automatically frees the oil of entrained air and gas as it returns from the generator. This separated air and gas is vented to the atmosphere.

A gas control system feeds the hydrogen into the generator at 99.6 per cent purity and scavenges contaminated gas to maintain constant high casing purity.

Finally, nine automatic protective devices give the operator immediate warning of unusual mechanical or operational condition.

Leader in Turbine-Generator Progress

GENERAL ELECTRIC



MARK M. PATTERSON, Manager of Sales, Medium Steam Turbine, Generator and Gear Department, explains the G-E ventilation system used with hydrogen cooled generators.

G.E. engineers 3-path ventilation sytem for more uniform cooling of entire unit

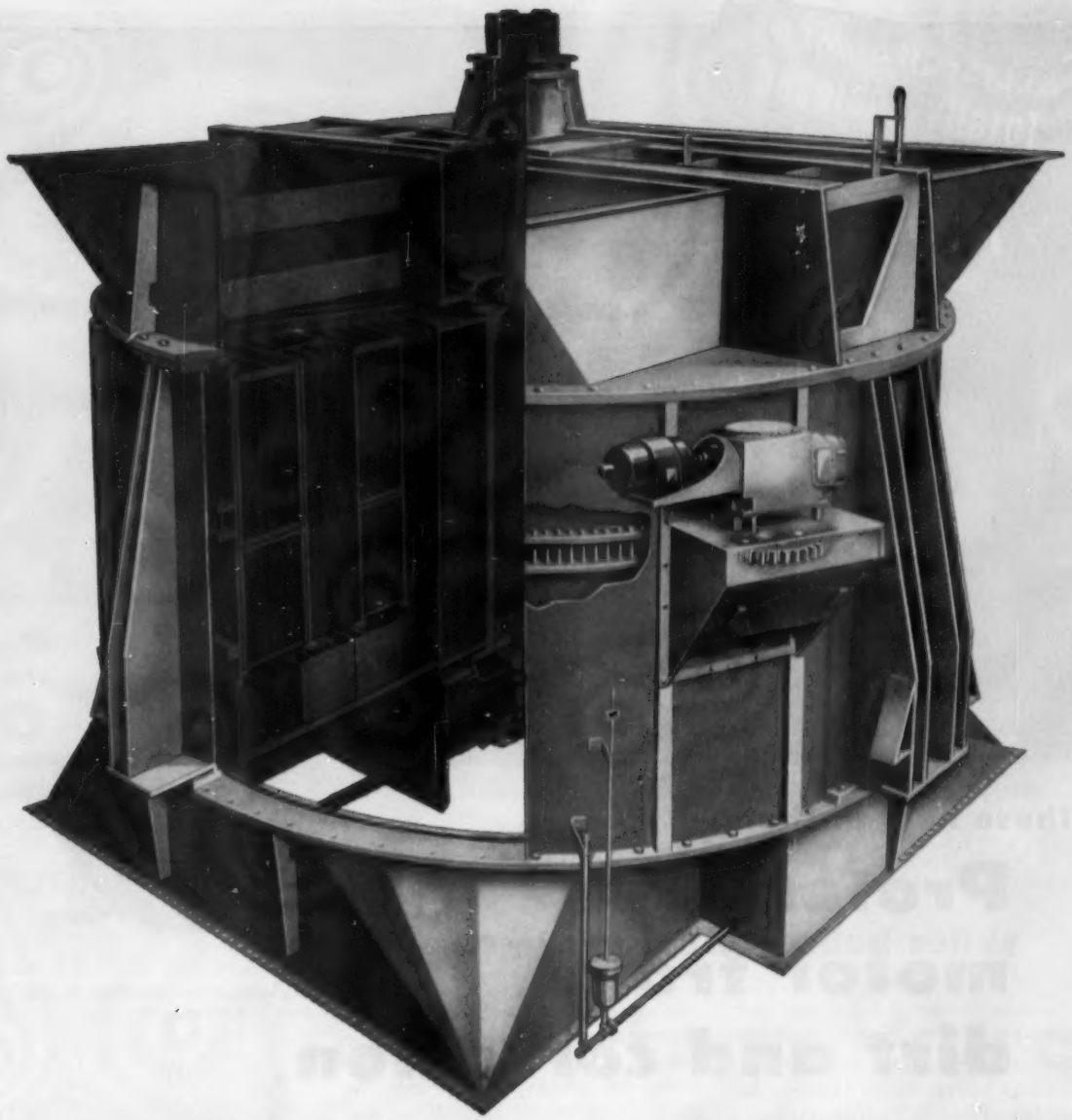
The superior cooling effect of hydrogen gas is directed throughout the entire unit. Fans mounted at each end of the generator rotor force the cooling gas into three internal paths:

1. **Over the stator end-turns** to passages between the core and wrapper plate, then radially inward through ducts in the laminations to the air gap, and radially outward through adjacent cooling ducts in core.
2. **Over the stator and rotor surfaces** of the air gap and radially outward through cooling passages of the stator core.
3. **Over the rotor end windings,** through internal ventilating ducts of the rotor to the air gap, and through the discharge passages of the stator core.

From the discharge passages of the core, the gas goes to the surface coolers and returns to the inlet side of the fans. The pressure-drops through the passages are balanced to maintain a proper proportion of total gas cooling each path and uniform cooling of the length of the generator. The many advantages obtainable only from the reliable G-E hydrogen-cooling system, as applied to medium-size machines, are primarily due to the engineering advances described on these four pages. There are others and there will be more, because G-E engineers never stop working to make certain G-E hydrogen cooling is the best that can be designed. General Electric Co., Schenectady 5, N. Y. 256-14

Progress Is Our Most Important Product

GENERAL ELECTRIC



THE LJUNGSTROM AIR PREHEATER

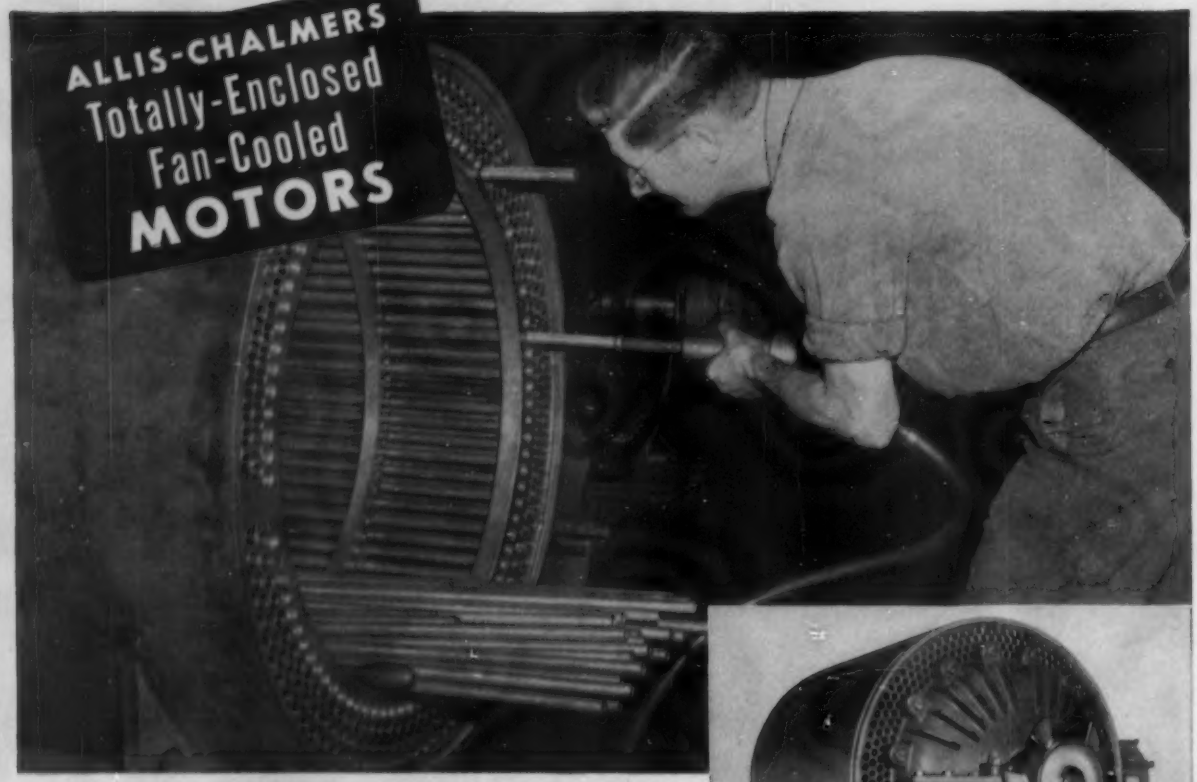
cuts fuel costs in hundreds of plants

The Ljungstrom Air Preheater has proved its value in industrial and utility plants throughout the country. That's why every year, a constantly increasing percentage of the total installed boiler capacity is Ljungstrom-equipped. *Your fuel costs will drop, too,* when you equip your boilers with Ljungstroms. The extremely high efficiency of the regenerative design means the greatest possible recovery of waste heat . . . with substantially lower fuel requirements.

If you are planning a new boiler installation — or expanding or modernizing your present one — let our engineers show you how the Ljungstrom can raise over-all efficiency in your plant.

Ljungstrom Air Preheaters are now available for boilers of any type or capacity from 25,000 pounds of steam per hour up.

The Air Preheater Corporation 60 East 42nd Street, New York 17, N. Y.



3600-rpm explosion-proof motor with fan housing removed to show unidirectional fan.

These heat exchanger tubes

Protect this motor from dirt and corrosion

COOLING AIR is carried through the heat exchanger tubes with sufficient velocity to expel practically all kinds of dirt. If oily or sticky dirt should cling, tubes can be ramrodded clean on the spot in a few minutes because tubes are straight and tube ends are exposed. Also, the tubes are distributed uniformly around the perimeter of the stator yoke and along its full length — cooling all parts of the motor evenly.

Choice of Corrosion-resistant Materials

You can lick corrosion with this motor, too. Tubes are available in a variety of materials to meet practically any corrosive atmospheric condition. Allis-Chalmers tube-type motors have long and successful experience in such difficult applications as caustic plants, refineries and petrochemical plants, power plants with fly ash problems and many others.

Get Complete Information

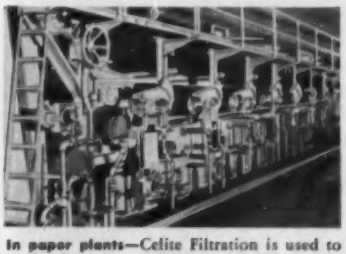
Next time you need a motor for a dirty or corrosive location or for outdoor operation in all kinds of weather, call your Allis-Chalmers District Office. Get complete information on Allis-Chalmers tube-type totally-enclosed, fan-cooled and explosion-proof motors. Or write Allis-Chalmers, Milwaukee 1, Wisconsin, for Bulletin 51B7149. Available in ratings on frames larger than NEMA 505 up to 3000 hp.

A-4559

ALLIS-CHALMERS

CELITE FILTRATION controls water purity—removes *all* suspended solids

In oil wells—output is boosted by repressurizing wells with water to force out accumulated oil. Celite Filtration purifies water to the extreme degree required—removes the minute suspended impurities which would otherwise clog the microscopic pores of sandstone.



In paper plants—Celite Filtration is used to purify the large quantities of water used in paper formation. Waste water may be filtered for reuse by the same process. Celite filter cakes can withstand many times the pressure of an ordinary filter bed. No pH control is necessary with Celite. *T.M. Reg. U.S. Pat. Off.

CELITE* FILTRATION provides the *right degree* of purity that you require for industrial process water. It removes sediment which may cause costly downtime or damage to expensive plant equipment. And if your application requires greater purity, Celite removes even such fine suspended solids as amoebae and algae, many of which cannot be filtered out by other methods. Moreover, fast, economical rates of flow can be maintained with Celite Filtration

This selectivity in degree of water purity is made possible because Celite comes in nine standard grades . . . each designed to filter out impurities of specific size and type. Carefully processed from the purest deposits of diatomaceous earth, Celite always has utmost uniformity of product. Whenever you reorder, you are assured of the same accurately graded powder.

Celite Filtration offers many other advantages, too. Important space savings are achieved in the installation, longer filtration cycles are obtained, and less backwash water is required for cleaning the filters than with ordinary systems.

Celite Filtration provides pure process water for boiler make-up, heat exchangers, circulating water for towers . . . and many other industrial uses. It will pay you to investigate the advantages of Celite for your particular application. To have a Celite engineer study your problem and offer recommendations, simply write Johns-Manville, Box 60, New York 16, N. Y. In Canada, 199 Bay Street, Toronto 1, Ontario.

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville CELITE FILTER AIDS

How to Select an Economical Temperature Regulator

First of all, what does economy mean where temperature regulators are concerned? In some industries it means improvement of product or reduction of spoilage through closer control of process temperatures. In others, it means the paring down of operating expense. The price of the regulator itself is a relatively small factor.

Today's buyers are shopping for:

1. Accuracy of control — not only when the regulator is new, but throughout its service life
2. Dependability — to prevent loss of production time
3. Minimum installation and maintenance cost

Here are a few tips on what to look for when you're installing a new or replacing an old temperature regulator —

Packless construction . . . and for this reason: A diaphragm operated, packless regulator minimizes friction. There are no closely fitted parts to stick or bind because of uneven expansion or collection of foreign matter. Also, there's less maintenance, since no repacking is ever required.

A guarantee against wire drawing of the seats and discs. Insist on it. This guarantee in combination with single seat design assures you of tight shutoff; you avoid expensive steam losses as well as loss of product in a process application.

Broad control range. In a standard regulator you should expect a control range of 100 F. And make sure the unit you select has a vapor tension thermostat that can take over-temperatures of at least 100 F.

Easy maintenance. Why ask for grief? Your temperature regulator should be basically simple in design so that it can be serviced by average plant personnel. All parts should be readily accessible for testing and cleaning.

Double duty. There's no point in buying a separate pressure regulator when you can select a temperature regulator that combines both temperature and pressure control within the same unit.

Self-operating. Make sure you get a regulator that operates on its own initial pressure. By doing so, you avoid the purchasing and maintenance of an air compressor plus air piping, and you're sure of uninterrupted operation during electric power failures.

• • • •

All of these points are important to you when it comes to selecting an economical temperature regulator. Perhaps you didn't realize you *could* expect so much. And perhaps you didn't realize that Spence Temperature Regulators offer all these features and more. May we send you our Bulletin T 500 containing further details? SE 120

SPENCE ENGINEERING COMPANY, INC.
Walden, New York

SLUDGE

Cleaning downcomers cost us 5 working days!

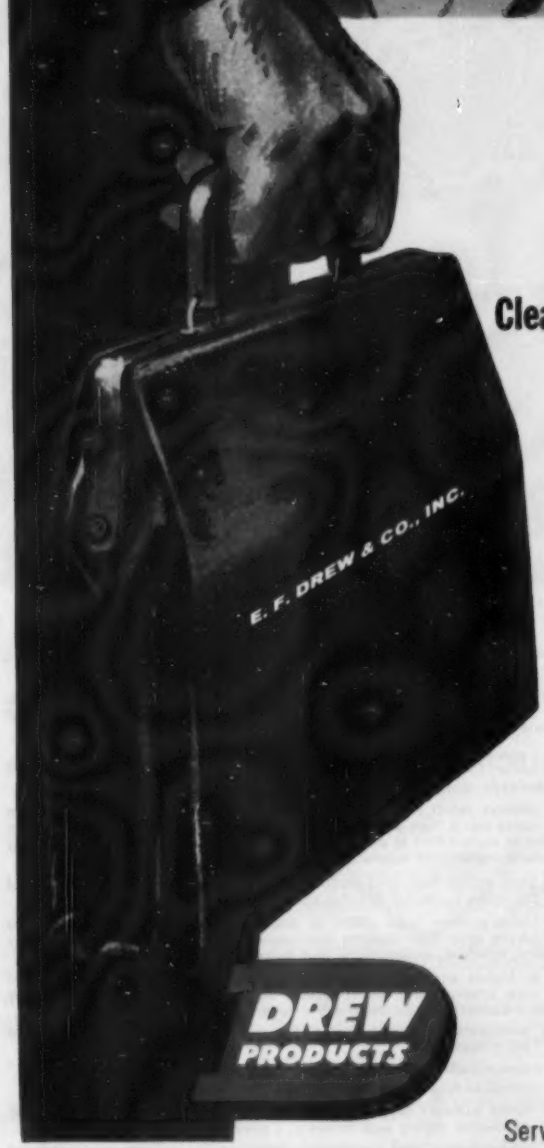
A large midwestern steel mill presented this serious problem to the Drew engineer.

The solution? As simple as this:

The Drew man, an experienced industrial water engineer, made a thorough study of the boiler plant and operating conditions. Pertinent water and sludge samples were analyzed at the modern Drew laboratories, and results interpreted. A course of action was charted, including the use of Drew Sludge Conditioner "U-14-L" and other treating chemicals.

The result? Sludge eliminated and boilers cleaned annually with just a hosing! Foaming—a long-existent problem was ended. As an added bonus, critical boiler outages and steam shortages are now "just a memory."

Call the Drew man, he can assist in solving your industrial water treating problems, too. Write for our brochure, "Complete Boiler Water Conditioning," and the address of the nearest Drew office. No obligation, of course.



Power Chemicals Division

E. F. DREW & CO., INC.

15 East 26th Street, New York 10, New York

SAN FRANCISCO • CHICAGO • PHILADELPHIA • BOSTON • DALLAS • ASHEVILLE, N.C.
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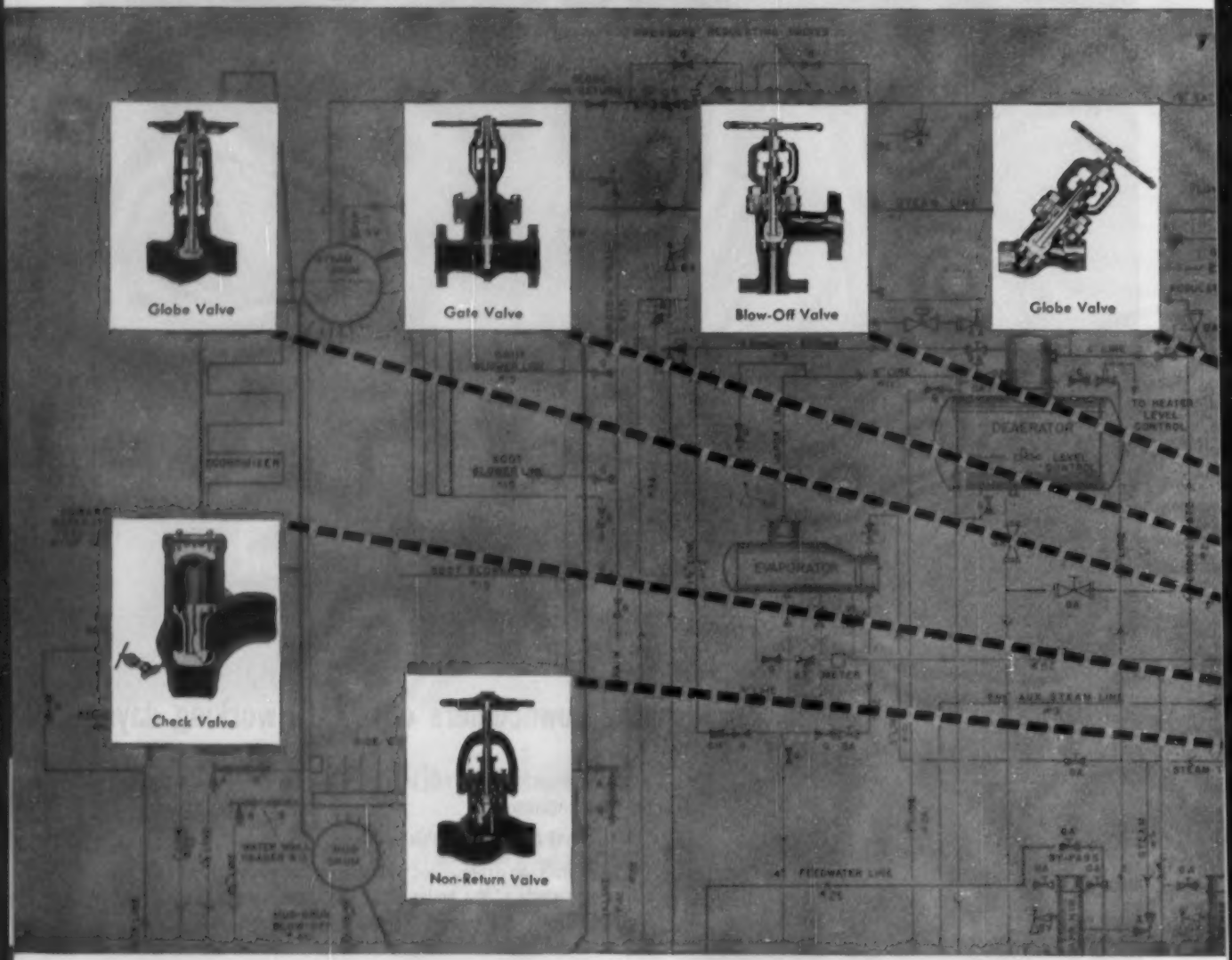
Service throughout the United States, Canada and South America

What you should know about



Fifty years ago Edward designed the first steel blow-off valves to solve the troublesome problem of blowing down boilers operating at 250 lb sp. Over the years continuous research and experience gained by solving valve problems have revealed many facts about steel valve selection, operation, maintenance and repair. Here are some of the most important.

INSTALLATION IDEAS . . . that can save money, increase piping and valve efficiency.

1 Consider using an angle valve in place of an elbow and a valve for reduced installation costs and operating convenience.

2 To hold valve expenditures to a minimum, use valves of standard construction and avoid high cost special designs. Presenting the problem to competent valve engineers such as those at Edward often results in money saving suggestions.

3 Wherever possible, install stop valves with the stem up to facilitate easy, quick lapping the seat. Considering maintenance and repair for each valve at the time of installation will reduce costs later.

4 Provide for convenient manual operation of ALL valves including non-return and motor operated valves, regardless of the frequency of the need for such operations, as a safety measure.

5 Install check valves and non-return valves so that pistons travel vertically to minimize danger of "hang-ups" or incomplete closures.

6 Reduce power consuming turbulence and wear in small forged valves by installing "inclined stem" valves.

7 For temperatures over 850°F welded bonnet or pressure-seal valves are more dependable.

8 Place strainers in lines to protect delicate, expensive gages, regulators, pumps, valves, traps, etc., to increase their dependability and cut future maintenance and replacement expense.

SELECTION POINTERS . . . that reduce maintenance cost and foster safe, dependable valve operation.

1 Always select the proper size valve for each service. Too small a valve has a high pressure drop and wastes power. Too large a valve requires more effort to operate and may cause excessive wear especially in check valves and non-return valves.

2 Stop valves that give positive shut-off regardless of the position of the valve make for greater efficiency and installation freedom.

3 Using modern type globe or angle valves in place of gate valves where drop-tight closures are required is recommended for repairability, tightness, adaptability and dependability.

4 In higher pressure-temperature services, several desirable features give pressure-seal valves distinct advantages over old style, heavily bolted bonnet designs. Here are a few:

(a) pressure-seal bonnets stay tight regardless of temperature-pressure variations;

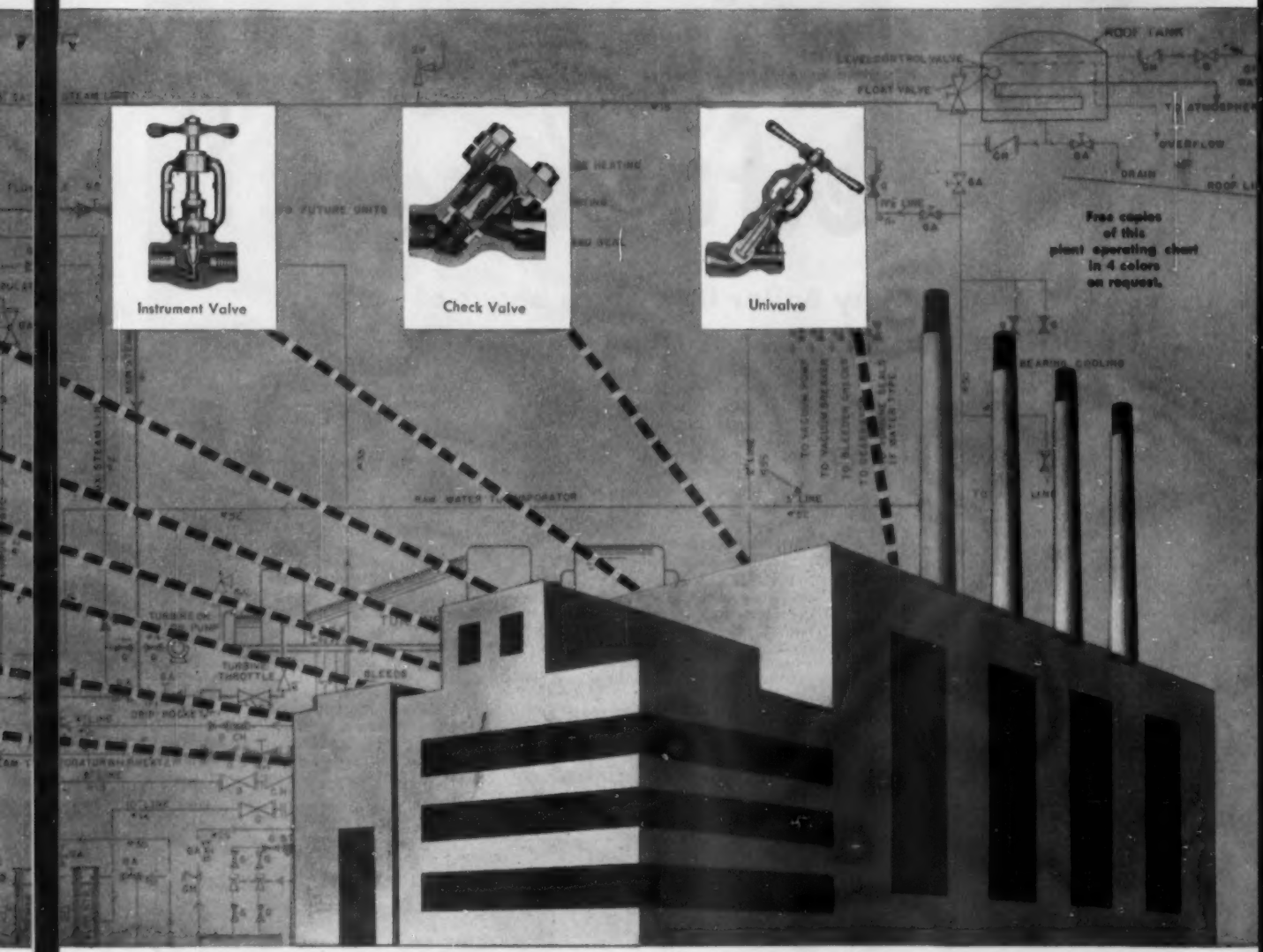
(b) fewer bolts, lighter covers and bonnets reduce maintenance costs;

(c) pressure-seal offers a higher degree of part interchangeability;

(d) lower pressure drop in streamlined pressure-seal designs permits use of smaller piping and valves . . . saving space, weight and costs;

(e) and pressure seal construction improves streamlining which reduces wear-inducing turbulence;

STEEL VALVES*



5 When selecting check valves, remember the piston type has at least five big advantages over the swing type:

(a) dashpot action of piston type check valves prevents slamming, eliminates damaging shock;

(b) disks give a tighter seal;

(c) more complete guiding minimizes vibration of moving parts;

(d) angle designs to replace elbows are possible in piston type check valves;

(e) disks can be easily re-lapped when necessary.

6 Piston type check valves and non-return valves give greater efficiency and more positive operation when the zone above the disk is connected to the outlet port to equalize the pressure in these areas. A connection such as the Edward Equalizer increases disk lift, cuts vibrations, reduces pressure drop.

7 Swivel disk construction with a self-centering feature on stop valves and blow-off valves eliminates seat-disk galling because the stem turns on disk rather than disk turning on the seat.

8 In blow-off service select sets in which both valves are the same type for dependable, drop-tight closing and interchangeability of parts and for repacking under pressure be sure both have positive backseats.

9 Gate valves with accurately aligned stem, guide ribs that prevent wedge drag and hard surfaced seats in bodies of uniform metal sections reduce maintenance. Hydrostatic testing of both sealing surfaces at the same time insures greater dependability.

10 By all means avoid gadgety designs. Long, dependable service with freedom from maintenance should be the primary consideration.

VALVE INDUSTRY STANDARDS... that are an outgrowth of the Edward "Firsts" in valve research and development.

1 FIRST steel blow-off valves.

2 FIRST Impactor handwheel to make manual operation of large valves easier.

3 FIRST inclined stem globe valve to reduce pressure drop and turbulence.

4 FIRST streamline internal contours to minimize pressure-loss.

5 FIRST Pressure-Seal non-return valves.

6 FIRST Equalizer for check and non-return valves to stop wear-producing vibrations and increase lift of disk piston.

7 FIRST cored-out, streamlined guide ribs for positive three-point guiding throughout disk travel.

8 FIRST Evalthrust ball-bearing yoke bushing construction for easier valve operation.

9 FIRST use of exclusive Evalizing electro-plating process to lubricate operating parts and protect them against corrosion.

The valves highlighted in this diagram are only a few of the complete line of cast and forged steel valves built by Edward.

Edward Valves, Inc.

Subsidiary of ROCKWELL MANUFACTURING COMPANY

1230 W. 145th ST.,
EAST CHICAGO, INDIANA

Another Product

Revolutionary Performance!

Riley Boiler Unit gives bonus of 20,000 pounds per hour of steam to Masonite Corporation

Here's the maximum capacity guaranteed to Masonite by Riley Stoker Corporation:

50,000 lb. continuous
60,000 lb. for 15 min. peaks

And here's the Masonite report on performance: "For the past 75 days the average hourly load on the new boiler has been 70,000 pounds with peaks of one and more hours' duration of 75,000 pounds."

This same installation called for a guaranteed air heater gas temperature not in excess of 395 degrees at 50,000 pounds of steam per hour. In actual operation at 54,500 pounds of steam per hour, the air heater exit gas temperature was only 377.5 degrees!

No wonder Riley Stoker Corporation, Worcester, Massachusetts, is so well known among leading plants throughout the nation for the highly efficient performance of its boilers!

Coppus-Dennis FANMIX Burners Were Installed

To assure such revolutionary performance, Riley specified Coppus-Dennis FANMIX Burners for its boilers. The exclusive FANMIX action — on *all* Coppus burners, gas as well as combination gas-oil — is the reason for such performances.

FANMIX : Better Combustion : Better Efficiency : Higher Ratings

FANMIX burners, with their *revolving orifices*, give violent mechanical mixing and agitation of gas and air and, therefore, instantaneous and complete combustion with *minimum excess air* (5% excess air not unusual).

Furnace space is not required for mixing; therefore, *higher boiler ratings* are easily obtained.

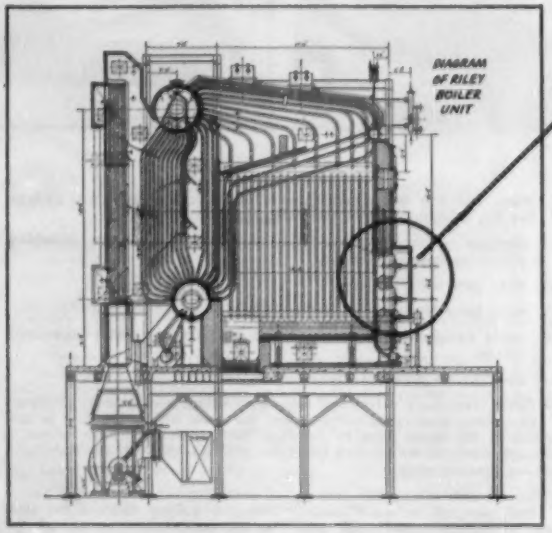
FANMIX burners, with shorter flame than any other burner, cannot cause flame impingement.

FANMIX burners, incorporating a *fan* as an integral unit, have *no draft loss* across the burner. Therefore, regardless of draft conditions, increased ratings are possible.

FANMIX action, with its quick completion of combustion, gives *lower* exit gas temperatures.

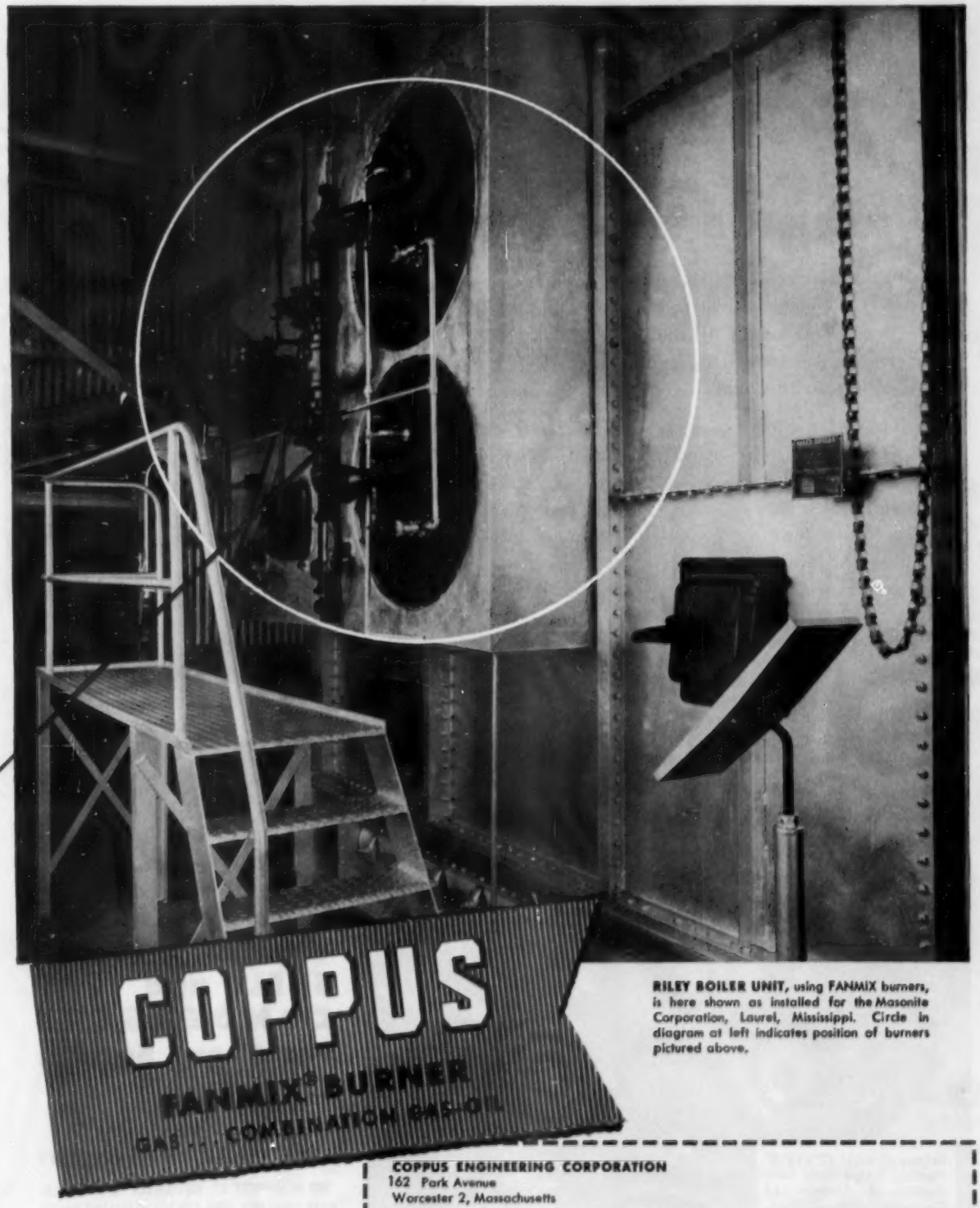
Plan now to take advantage of Coppus-Dennis FANMIX action with your present boiler. Remember — no forced draft equipment nor increase in stack nor increase in furnace volume is required for *FANMIX* operation to get increased capacity. And on *new* boilers, FANMIX lets you plan on reduced combustion space, higher ratings, less stack height or reduced induced draft capacity, and *no* forced draft equipment. Mail coupon today. Sales offices in *Thomas' Register*. Other "Blue Ribbon" Products in *Chemical Engineering Catalog, Refinery Catalog, Best's Safety Directory, and Mining Catalogs.*

JET REACTION is utilized to rotate fan which is integral part of burner. Automatically proportioned high velocity air passes at right angles through fuel to create ideal mixture for fast, complete combustion and peak efficiency.



Well-Known Users of Riley Units with FANMIX Burners Include:

Publicker Commercial Alcohol Co.
Monsanto Chemical Co.
Gaylord Container Corp.
Commercial Solvents Corp.
Celanese Corp. of America
Gulf Power Co.
Mississippi Power Co.
Eagle-Picher Lead Co.
Humble Oil & Refining Co.
Godchaux Sugars, Inc.
Kennecott Copper Corp.
Nicholson File Co.
Bird & Son, Inc.
— and many others



RILEY BOILER UNIT, using FANMIX burners, is here shown as installed for the Masonite Corporation, Laurel, Mississippi. Circle in diagram at left indicates position of burners pictured above.

SEND COUPON for further information. Coppus engineers FANMIX burners to your individual requirements.

PLEASE ATTACH THIS COUPON TO YOUR COMPANY LETTERHEAD

COPPUS ENGINEERING CORPORATION
162 Park Avenue
Worcester 2, Massachusetts

Please send complete data on Coppus-Dennis FANMIX Burners. I'm particularly interested in
☐ gas ☐ combination gas-oil.

Name..... Title.....

Company.....

Address.....

City..... Zone..... State.....

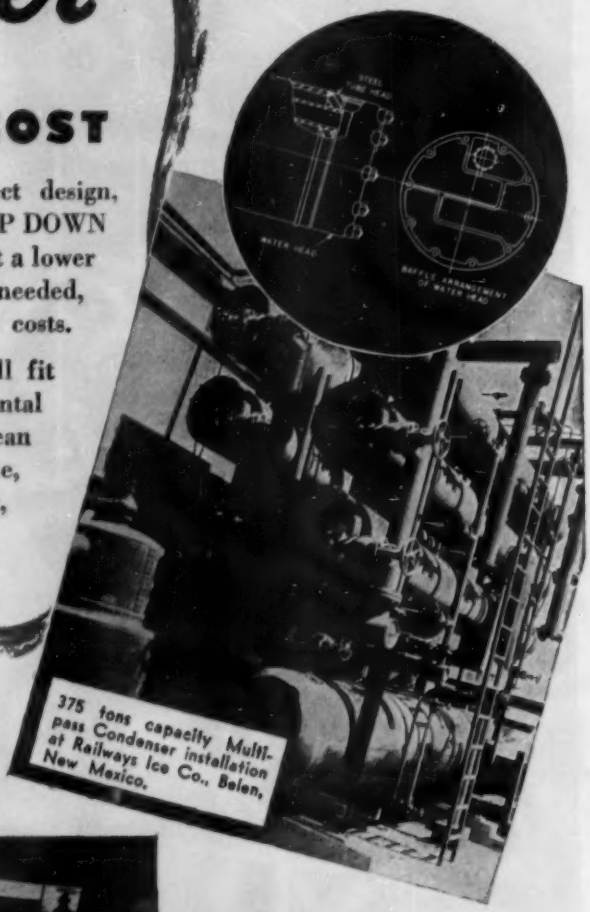
$ave Power
and
REFRIGERATION COST

Vogt Condensers, because of their correct design, STEP UP the rate of heat transfer and STEP DOWN head pressures. With the liquid delivered at a lower temperature, smaller compressor capacity is needed, saving in original as well as operating costs.

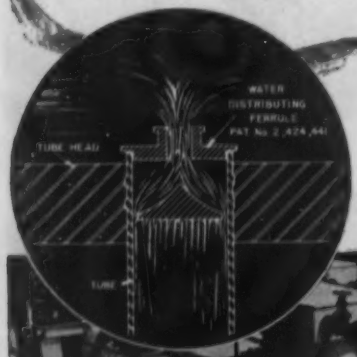
One of the two basic types illustrated will fit your operations exactly. Install Horizontal Multipass (closed type) for use with clean waters. Where the water is hard, forms scale, contains mud or promotes fungus growth, Vertical Single Pass (film type) which can be cleaned in operation, are recommended.

Horizontal Multipass Condensers
(Closed Type)

Water circulated in tubes traverses the length of the unit a number of times as determined by baffles in the heads.

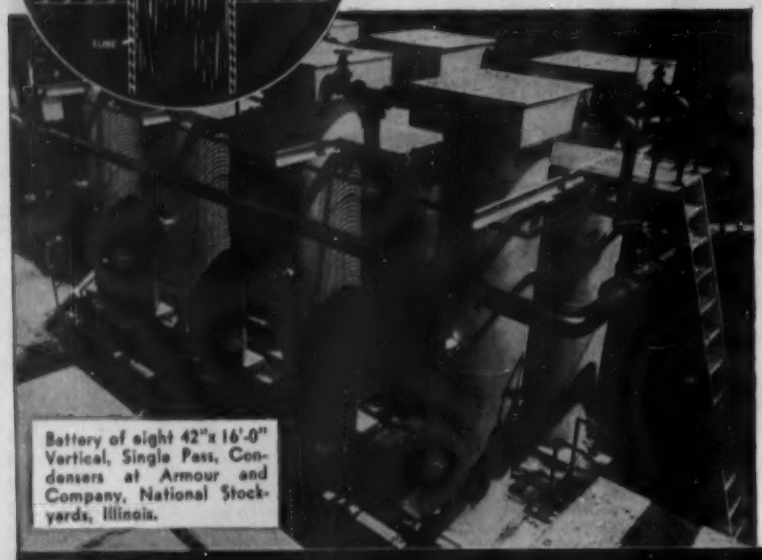


375 tons capacity Multipass Condenser installation at Railways Ice Co., Belen, New Mexico.



Vertical Single Pass Condensers
(Film Type)

Patented ferrules give equal distribution of water to and over the surfaces of all tubes in a unit.



Battery of eight 42"x 16'-0" Vertical, Single Pass, Condensers at Armour and Company, National Stockyards, Illinois.

HORIZONTAL and VERTICAL TYPES SHELL and TUBE CONDENSERS For Every Service

Write For Bulletin RC-2

HENRY VOGT MACHINE COMPANY
INCORPORATED
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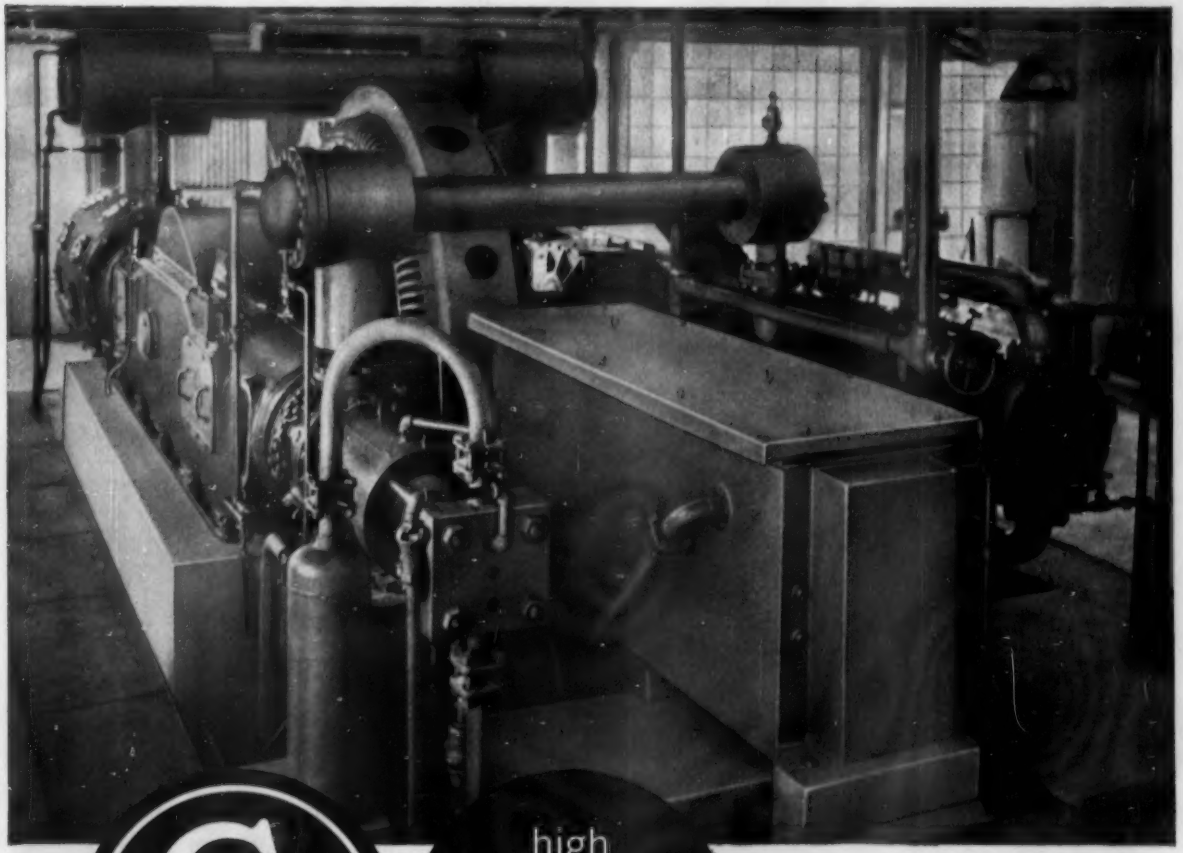
Branch Offices: NEW YORK, CHICAGO, CLEVELAND, DALLAS, PHILADELPHIA, ST. LOUIS, CHARLESTON, W. VA.

Vogt REFRIGERATION CONDENSERS



high pressure compressors

A typical CP high pressure compressor installation is this horizontal, four-corner, five-stage compressor delivering gas at 3,000 psig. Intercoolers, with extra-large separators, are machine-mounted, simplifying piping layout. Low compression ratio per stage, low rotative speed and roller bearings assure low power consumption and minimum maintenance expense.

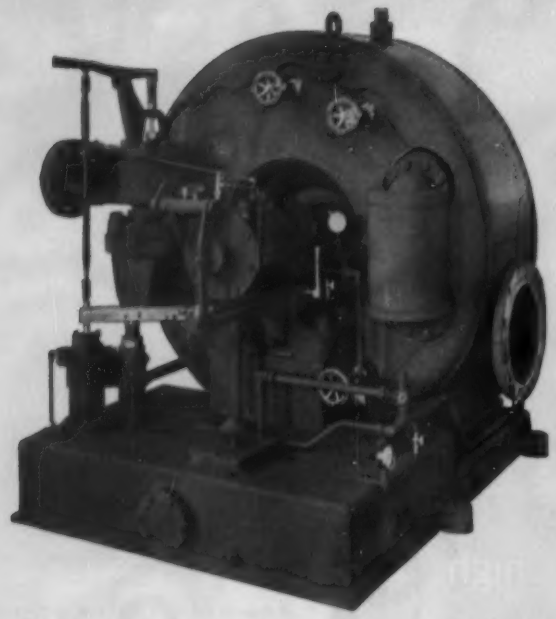
...built to deliver up to 15,000 psig

There's a CP Compressor suited to your special requirements for pressures up to 15,000 psig. They're available in vertical or horizontal, stationary, portable, or semi-portable package types . . . liquid or air cooled . . . manual or automatic capacity control with fixed or variable volume clearance pockets . . . electric motor or steam driven. For information write *Chicago Pneumatic Tool Company, 8 East 44th Street, New York 17, New York.*

Chicago Pneumatic

PNEUMATIC TOOLS • AIR AND GAS COMPRESSORS • ELECTRIC TOOLS • DIESEL ENGINES • ROCK DRILLS • HYDRAULIC TOOLS • VACUUM PUMPS

TROUBLE-FREE TURBINE OPERATION STARTS HERE



Terry solid wheel turbines have become a symbol for dependable, trouble-free operation. The reason—simplicity and ruggedness of construction.

Take the rotor, for instance. It's a solid forging in which a series of semi-circular buckets is milled. There are no separate parts to loosen or work out. Since the only function of the blades is to form a series of pockets, any wear which might occur would not materially affect horsepower or efficiency.

It is impossible for the blades to foul. They have large clearances and are further protected by the projecting rims at the sides of the wheel. As the side clearances are also very large, end play can do no harm.

Simplicity outside too—as you can see from the photograph of the 1500 HP at 3500 RPM solid wheel turbine above. This turbine is equipped with an oil relay governor and forced feed lubrication to the bearings.

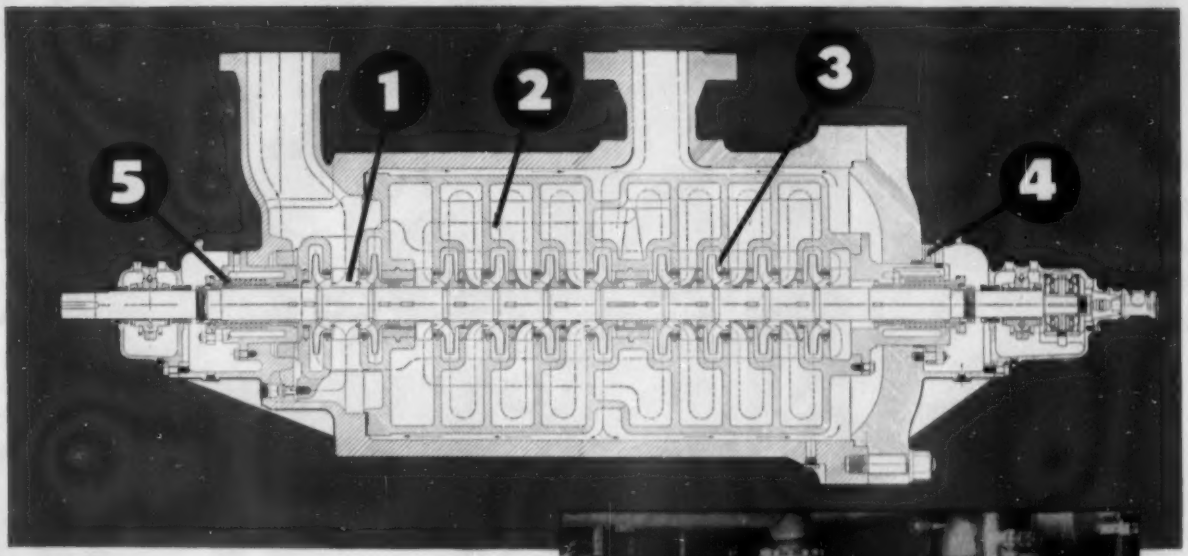
For more about these *work horses of industry*, send for a copy of bulletin S-116. No cost or obligation.

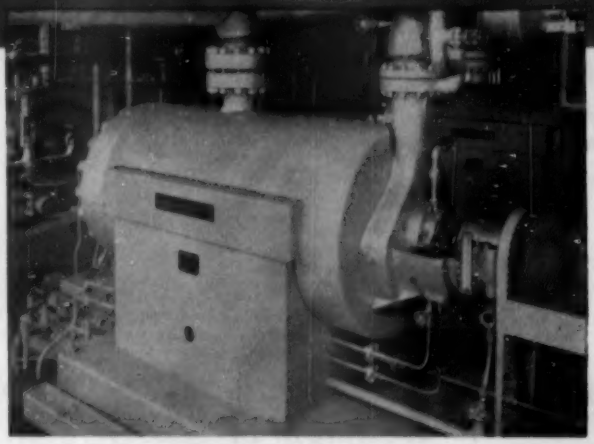
THE TERRY STEAM TURBINE CO.
TERRY SQUARE, HARTFORD 1, CONN.

TERRY

TT-1200

Get These 5 Features for Top Boiler Feed Pump Value





1 **Low NPSH** — First stage is two single-suction impellers face to face. NPSH requirement is very low, and interstage leakage is introduced into high pressure side of first stage to prevent flashing.

2 **Double-Volute Casing** — Radial thrust is neutralized regardless of variations in load. Bearings and wearing rings last longer, vibration is minimized.

3 **Back-to-Back Stages** — Arrangement of stages with center discharge maintains axial balance without balancing devices. Thrust from opposed stages cancels out. Any slight unbalance is taken up through a Kingsbury thrust bearing. Great simplicity reduces maintenance.

4 **Easy Casing Expansion Joint Inspection** —The casing expansion joint is brought to the outside where it is easy to adjust and where leakage can be detected and corrected quickly and easily.

5 **Five Sealing Options** —Gland seals may be standard packing, packingless, bleed-off, condensate bleed-in, or mechanical seal, depending on your exact requirements.

ALLIS-CHALMERS BARREL-TYPE BOILER FEED PUMP is the most modern high pressure boiler feed pump available today. Yet every feature has been tested and proved in power plant operation.

Check this pump point by point . . . check its performance in many power plants across the country. Get full details from your Allis-Chalmers representative or write for Bulletin 08B7899. Allis-Chalmers, Milwaukee 1, Wis.

A-4453

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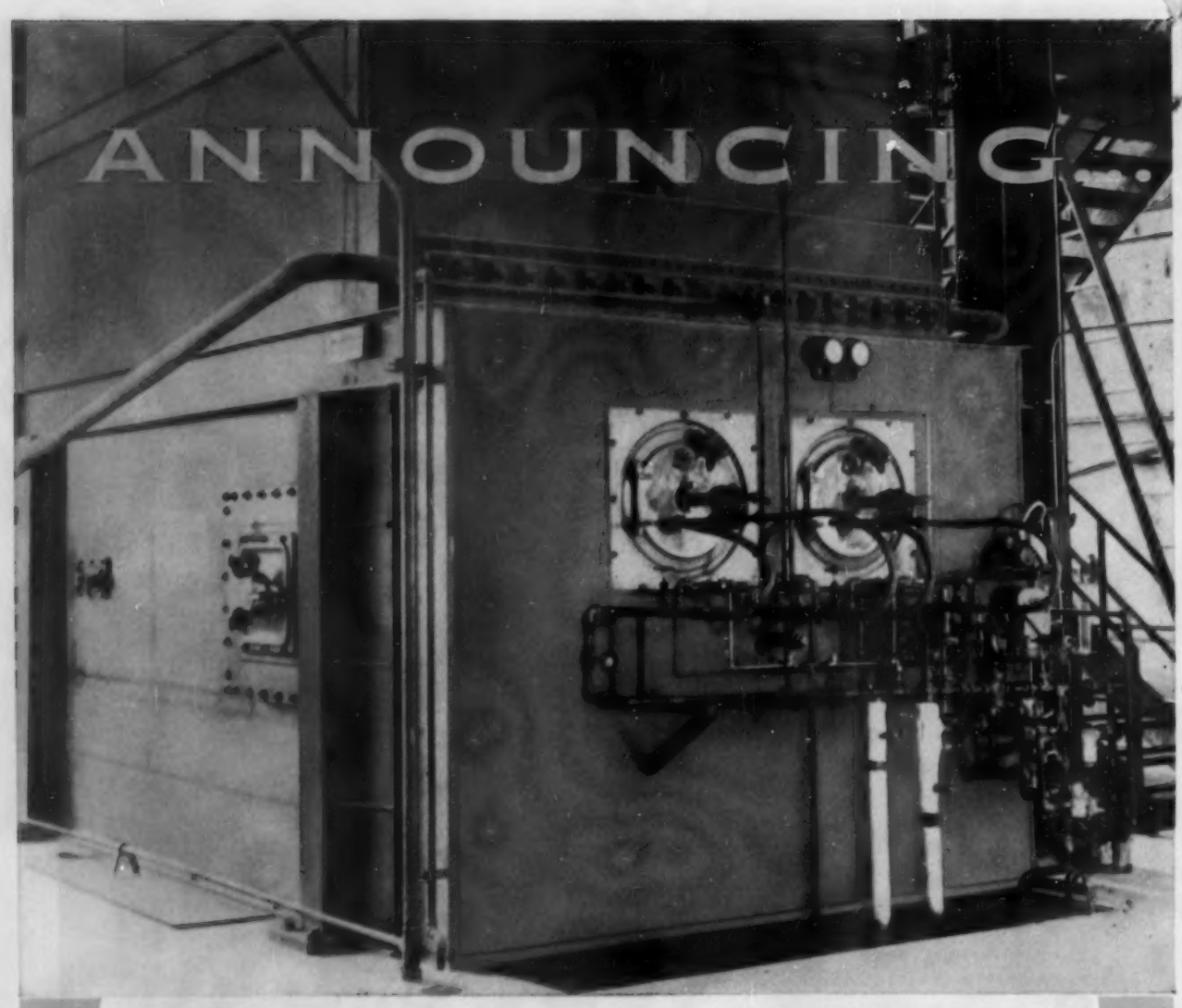


High-Temperature (H-T) Water has important advantages for Heating or Process. Here's Why . . .

HIGHER AVAILABLE HEATS are on tap. Many more Btu's are in a cubic foot of H-T water than in a cubic foot of steam at the same pressure . . . 53 times as many at 110 psi, for example. You'll get the heat you need for a lower capital outlay.

UNIFORM TEMPERATURE CONDITIONS result because boiler and system piping are all one. The greater storage volume, full of a higher Btu-carrying fluid, gives a heat reservoir from 40 to 100 times that of an equivalent steam system. In process plants, you can isolate special equipment for very fine temperature control, to produce a better product.

CLOSE CONTROL OF SYSTEM TEMPERATURE can be maintained either at the boiler or at individual pieces of equipment. Since temperature in the H-T water system need not be a direct function of system pressure, moderate adjustment does not affect boiler operation.

SIMPLIFIED BOILER OPERATION is a result of the system's inherent heat reservoir, and its independence in operating performance from boiler pressure swings. This permits use of automatic controls of proved reliability.

HEAT LOSS IS MINOR since H-T water systems are usually fully closed, constantly circulating water back to the boiler with no condensate losses. Thus, heat not used in process or heating returns to the boiler. This represents a fuel saving of 10-20% . . . one that's more apparent the longer you operate the boiler.

NO ELABORATE FEEDWATER TREATMENT is needed. Since most H-T water systems are closed, full of water and free from air spaces, makeup requirements are a few gallons a day at most. Furthermore, there can be no active corrosion resulting from air-contact of wetted surfaces. These add up to substantially lower operating and maintenance expenses.

STEAM TRAPS ARE UNNECESSARY, resulting in freedom from trapping problems and heat losses, and lower operating maintenance costs.

NO PIPING GRADIENTS are required, because there is no drainage from heat-consuming devices to consider. What's more, since the H-T water is under constant pressure, heating circuits can be arranged in any pattern, in any location.

The C-E La Mont Controlled Circulation Hot Water Boiler

for large heating and process applications

Combustion's high-temperature (H-T) water boiler is especially designed to utilize the inherent advantages of hot water over steam (see opposite page) for large central heating installations and for many process applications. Units are available in sizes from 10,000,000 Btu per hour up, for any fuel, with pressures up to 300 psi and water temperatures to about 425 F. The chief advantages of the C-E La MONT *Controlled Circulation* Hot Water Boiler are:

Complete control — System control over the H-T water movement is extended to the boiler at all heat rates, since the water is under positive, controlled pressure.

Low pressure loss — In many applications, because of the low pressure loss inherent in the design, the system circulating pumps are used to provide circulation through the boiler.

High furnace heat rates — The close spacing of furnace wall tubes offers greater wall protection, permits high heat rates in the furnace with reduced maintenance.

More efficient heat transfer — Since the water is positively circulated through the heating circuits, these circuits may be proportioned and arranged for maximum efficiency.

Lighter boiler weight — Less surface is needed because heating surfaces are more efficient and, with closely spaced wall tubes, setting thickness is reduced.

Any fuel — Boilers can be arranged for oil or gas burners, or spreader stokers. Special applications using other types of firing or waste heat are also possible.

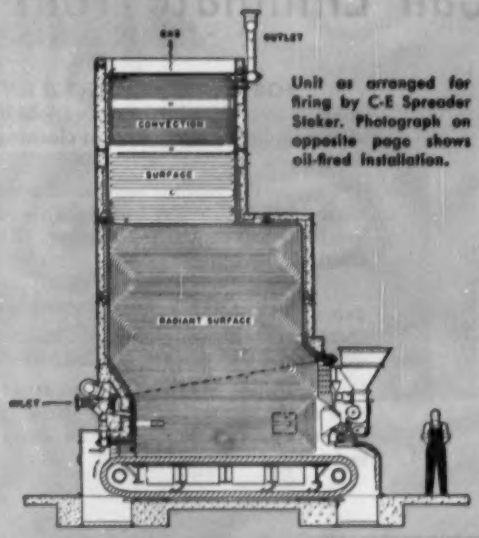
No induced draft fans — The completely steel-encased setting is designed for pressurized operation with oil or gas fuel.

Other design features — Single pass design (no baffles, low draft loss, simple stack arrangement); no headers in gas stream; small number of headers required and all are accessible from outside the casing.

If you have a heating or process job that's suitable for high-temperature water, it will pay you to look into a C-E La Mont installation. As compared to steam, it will give you a far simpler and less expensive distribution system and substantially lower fuel and maintenance costs, plus the specific advantages described at left. Write for further information.

TYPICAL APPLICATIONS OF H-T WATER

Space Heating	Heating Platens
Ovens	Hot Tables
Tanks	Snow Melting Coils
Kettles	Cafeteria and
Calendar Rolls	Kitchen Apparatus



Unit as arranged for firing by C-E Spreader Stoker. Photograph on opposite page shows oil-fired installation.

B-806

COMBUSTION ENGINEERING

Combustion Engineering Building • 200 Madison Avenue, New York 16, N. Y.

BOILERS, FUEL BURNING & RELATED EQUIPMENT, PULVERIZERS, AIR SEPARATORS & FLASH DRYING SYSTEMS, PRESSURE VESSELS, AUTOMATIC WATER HEATERS, SOIL PIPE

The New S·E·CO. Coal Valve
Can Eliminate Your Coal Valve Headaches

FOR EXAMPLE . . . it has *self-cleaning*, coined, ladder racks that cannot become clogged with coal, even on jobs having internal pressure. This feature alone can eliminate hours of time spent cleaning coal from the valve body, racks and pinions so that you can operate it.

. . . the pinions are also of *self-cleaning* design, located *above* the gate, an exclusive S-E-Co. design feature. This position helps keep the ladder racks clean and assures positive tooth engagement. This, together with the new husky sized racks, can eliminate your troubles with tooth breakage and subsequent time consuming repairs.

. . . large, 2-5/16" diameter, rollers, equipped with ball bearings, support the gate making sure it will move easily. These rollers have stainless steel shells to combat corrosion. Felt grease seals and stainless steel grease retainers with fittings for pressure lubrication insure their long life.

Dependability, minimum maintenance requirements and ease of operation are built into each S-E-Co. Coal Valve. Write for our new Bulletin #97 or for a local representative to call and assist you select valves to replace those that are not giving satisfactory service.

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BUNKER TO PULVERIZER AND
BUNKER TO STOKER EQUIPMENT

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We believe
ONLY THE HIGHEST QUALITY OF PRODUCT AND SERVICE TO OUR CUSTOMERS CAN BUILD A REPUTATION WORTHY OF OUR EFFORT.
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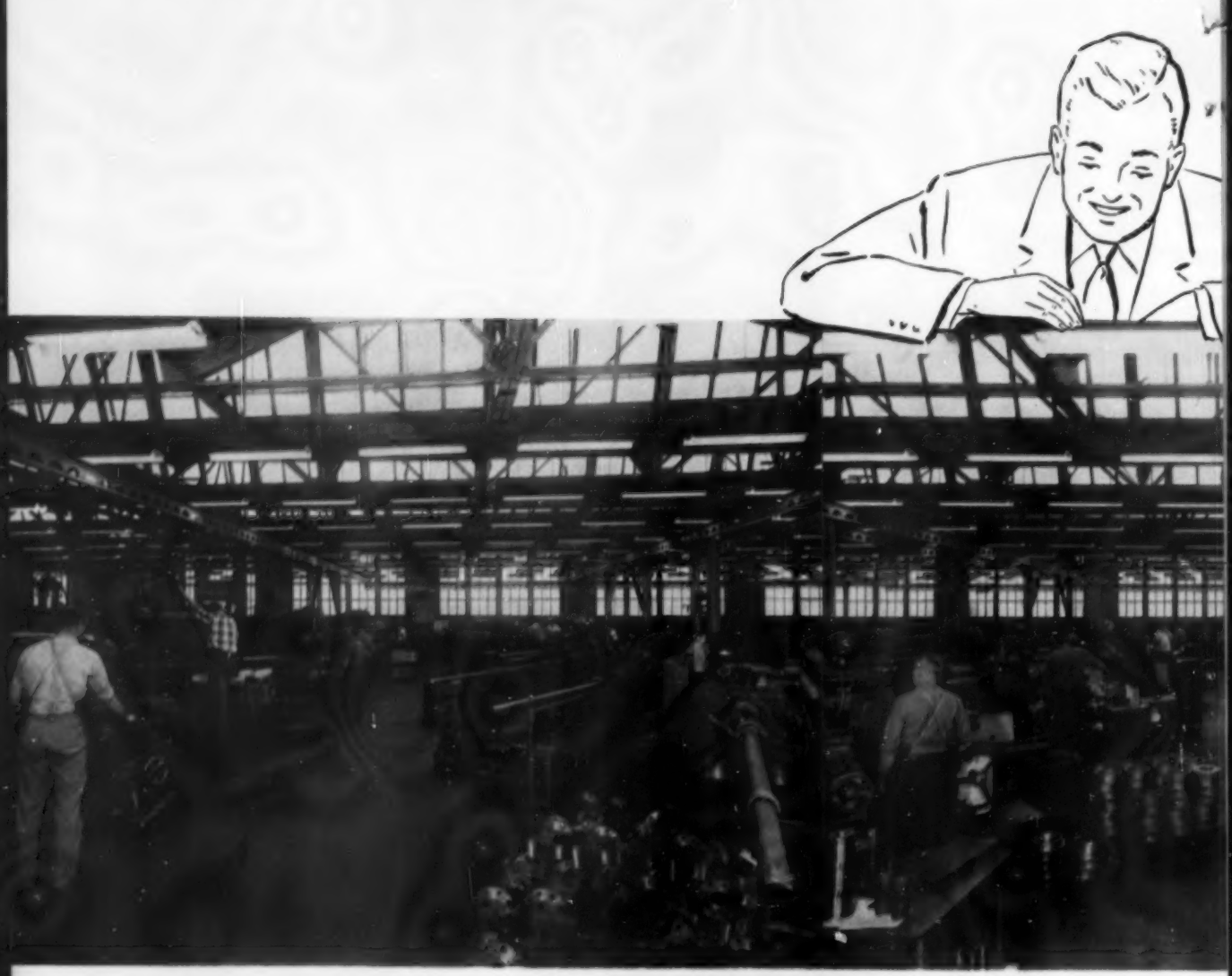

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CONTROLS AND MECHANICAL CLEANING FOR BOILERS

ERIE 4, PENNSYLVANIA

"No wonder your quality's high"

And it is. Because this kind of plant invites men to do better work.

Our workmen agree. They like the clean floors and aisles . . . the well-maintained machines . . . the high ceiling that makes this shop light and airy.

Surroundings like these attract men who take pride in their work. Here skilled men find it easy to live up to the Copes-Vulcan Code: "Only the highest quality of product . . . is worthy of our effort."

They know . . . as you do . . . that the best is none too good for your installation. That they must build into Copes-Vulcan equipment extra values that keep paying you dividends long after you've forgotten price.

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r 50 Years
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Manufacturers of: COMBUSTION CONTROL . . . DESUPERHEATERS . . . FEED WATER REGULATORS . . . HI-LO WATER ALARMS . . . PRESSURE REDUCING VALVES . . . PUMP GOVERNORS . . . SOOT BLOWERS.

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Main Office and Plant at ERIE, PENNSYLVANIA

Evenly matched or not...

there's enough difference to make all the difference

Before the bout, two fighters may look equally good to the fans. After a round or two, the differences begin to show up.

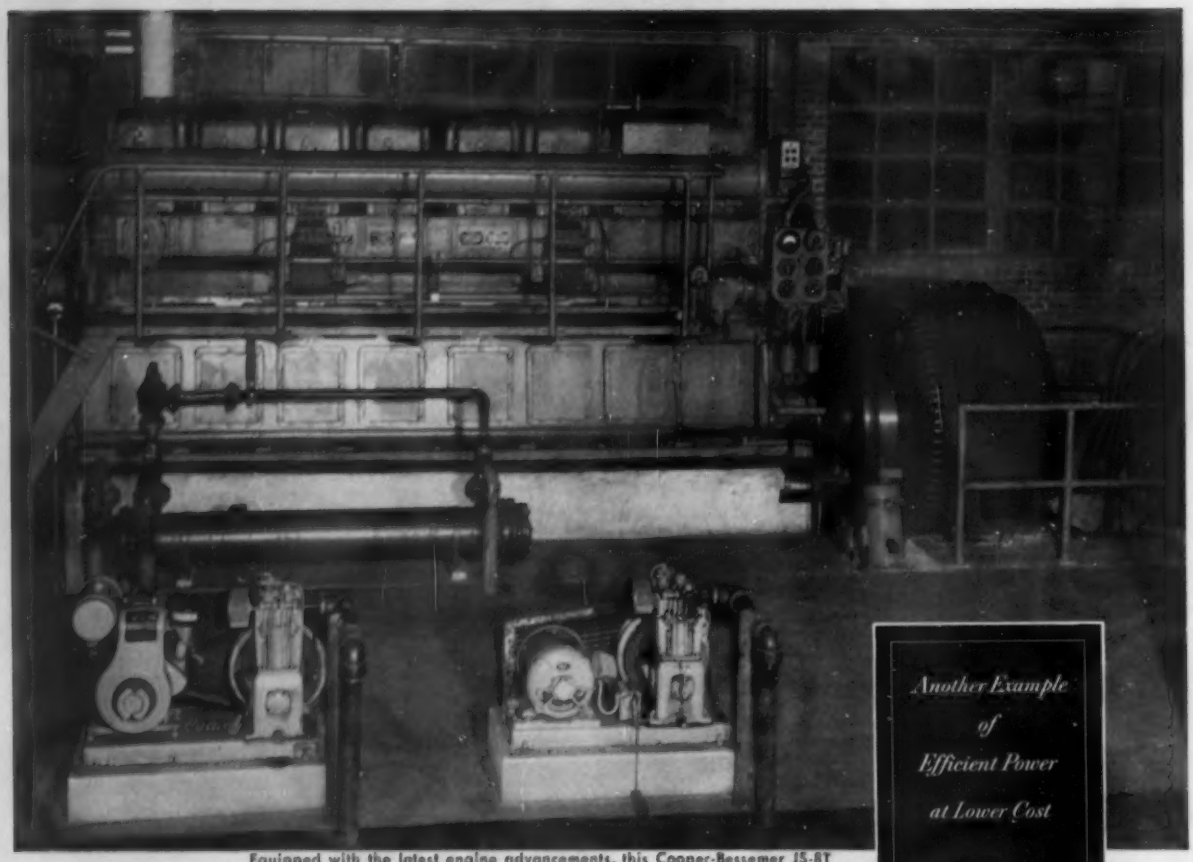
It's the same with heat exchanger tubes. They all start out looking pretty much alike, but under the test of day-in, day-out operation, Scovill Phosphorized Admiralty Heat Exchanger Tubes have consistently shown superior performance.

Hot-extrusion from Scovill Continuous-Cast billets means uniformity in the metal, uniformity of chemical composition and grain structure, uniformly high phosphorus content. It means sounder metal—smooth, dense, free from pits or porosity. These—plus Scovill's unrivaled Technical Application Services —are, indeed, differences that make *all* the difference in economical, uninterrupted service under tough operating conditions. Let us tell you more about them.

Scovill Manufacturing Company, Mill Products Division, 99 Mill Street, Waterbury 20, Connecticut. Phone PLaza 4-1171.

SCOVILL **HEAT EXCHANGER TUBE**

Phosphorized Admiralty • Admiralty • Arsenical Admiralty • Muntz Metal • Naval Brass • Red Brass, 85% • Deoxidized Copper
Arsenical Copper • Copper Nickel, 10% & 20% • Cupro Nickel, 30% • Aluminum Brass • Aluminum Bronze, 5% • Duplex Tube



Equipped with the latest engine advancements, this Cooper-Bessemer JS-8T at Breese, Illinois Light and Power, easily develops 1435 bhp at 450 rpm.

How "Packaged Power" *Pays Breese a BIG Bonus*

THE Cooper-Bessemer stationary generating engine in the Breese, Illinois Municipal Light and Power plant combines several unusual features that really pay off in greatly increased horsepower and unusually high thermal efficiency. To be exact, this 8-cylinder 13" x 16" supercharged JS engine develops 1435 bhp at 450 rpm — a rating out of the question only a few years ago, but now proved conservative.

To produce such horsepower, Cooper-Bessemer added, in addition to supercharging, pre- and after-coolers employing a Vapor Phase Cooling system. Moreover, for still further economy, steam from the engine's cooling water jackets is used to heat boiler feed water for previously installed steam turbines.

And here's a mighty important point . . . in spite of its horsepower, this Cooper-Bessemer unit continues to operate *quietly, smoothly, and with no noticeable surrounding heat.* Proved by performance, this modern JS has now taken over the full load at the Breese Plant . . . and with unprecedented economy.

If your plans call for complex generating and process service, or the most simple arrangement, you'll be money and performance ahead with Cooper-Bessemer. Ask our nearest representative for specific performance figures and estimated savings based on your particular power demands.

MOUNT VERNON, OHIO
COOPER-BESSEMER
GROVE CITY, PENNA.

New York, N. Y. • Washington, D. C. • Gloucester, Mass.
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Los Angeles, Calif • Chicago, Illinois • St. Louis, Mo.
San Diego, Calif • New Orleans, Louisiana • Cooper-Bessemer of Canada, Ltd., Halifax, Nova Scotia.

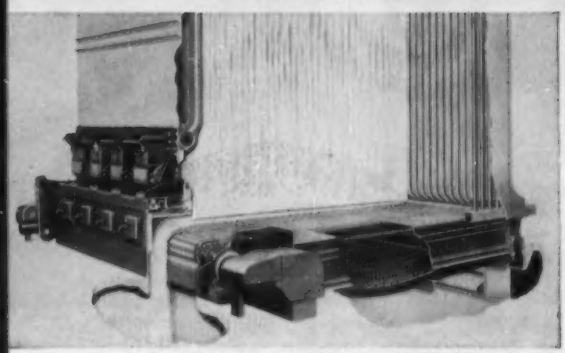
Let's take a NEW LOOK at spreader stoker firing

particularly

DETROIT ROTOGRATE

stoker advantages

One of five Detroit RotoGrate Stokers assembled before shipment to a mid-west public utility.



Detroit RotoGrate Stoker with two of the six Rotors removed to show the overlapping highly restricted grate designed especially for spreader stoker firing.

- **High Burning Rates** per square foot of grate area permit continuous operation with less expensive boiler and furnace design
- **Low Carbon Loss** results in high over-all efficiency
- **Superior Design** permits operation with low excess air
- **Wide Load Range** handled smokelessly with convertible grate area
- **Low Maintenance** compared to other coal-burning methods.
- **Burns All** bituminous coals and Lignite. Also bark, wood, bagasse and other refuse fuels, either separately or in combination with coal

• Contact our nearest District Office or your consulting engineer.

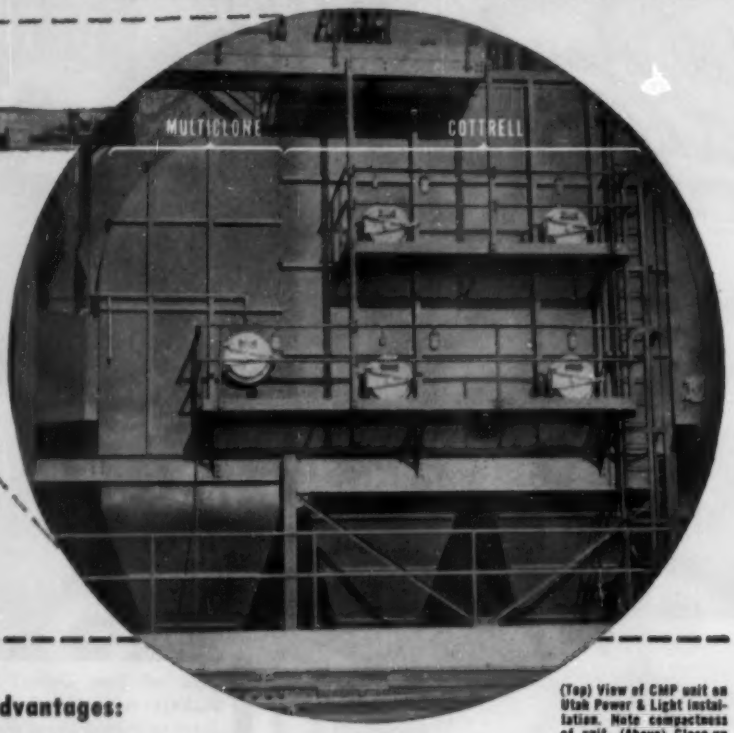
Backed by over a half century of experience. Complete manufacturing and service facilities.

DETROIT STOKER COMPANY

General Motors Building — Detroit 2, Michigan

District Offices in Principal Cities • Works at Monroe, Michigan

Consider these important advantages of a WESTERN PRECIPITATION CMP UNIT!



IF YOU are planning the installation of any type of fly ash recovery equipment—mechanical or electrical—it will pay you to investigate the extra advantages to be gained by installing a CMP Unit designed, engineered and constructed under *one* responsibility by Western Precipitation Corporation—*leaders in both electrical and mechanical recovery fields!*

(Top) View of CMP unit on Utah Power & Light installation. Note compactness of unit. (Above) Close-up of same installation.

Combines Mechanical and Electrical Advantages:

A CMP (Combination Multiclone-Cottrell Precipitator) Unit combines—in one compact installation—both mechanical and electrical recovery principles, so that maximum benefit is obtained from the advantages inherent in each method. The MULTICLONE section centrifugally cleans the gases of the larger and heavier fly ash particles (down to a few microns in diameter) . . . and the COTTRELL Precipitator then electrically removes the very small particles remaining in the gases. This combination arrangement has important advantages:

1. Using the MULTICLONE for cleaning out the heavier particles permits the bulk of the recovery operation to be performed with relatively low-cost equipment.

2. Using the COTTRELL for final clean-up insures unusually high recovery efficiency—approaching theoretically perfect, if desired—with a high efficiency, compact Precipitator unit.

3. Each type of unit—MULTICLONE and COTTRELL—can be arranged for its most efficient application. MULTICLONES may be connected to each separate boiler, if desired, and their draft requirement cut out when the boiler is down . . . while a central COTTRELL handles all gases and operates at higher efficiencies, with continued low power cost, when one or more boilers are down.

4. During soot-blowing periods, or while warming up cold boilers, the MULTICLONE efficiency usually increases, preventing overloads of detrimental carbon from reaching the COTTRELL.

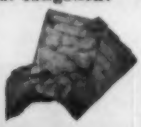
Only Western Precipitation Combines Multiclone and Cottrell "Know-How"—In ONE Organization!

A vital factor in obtaining maximum efficiency and economy in CMP installations is the proper balance of mechanical and electrical recovery equipment to the individual requirements of *each* application. Western Precipitation is unique in that it not only pioneered the commercial application of COTTRELL Electrical Precipitators over 43 years ago, but also has been a leader for many years in the *mechanical* recovery field with its widely-recognized MULTICLONE Collectors.

Result—Western Precipitation has the all-important "know-how" and experience in BOTH fields . . . knows from first-hand experience how to fit the *right* equipment in the *right* place, to do *your particular* job . . . and can provide the complete installation under ONE responsibility and ONE overall guarantee!

Let Our Experienced Engineers study your recovery requirements and make recommendations on the equipment best suited to your operations. A wire, phone call or letter to our nearest office places this unique "Know-How" at your service, without obligation!

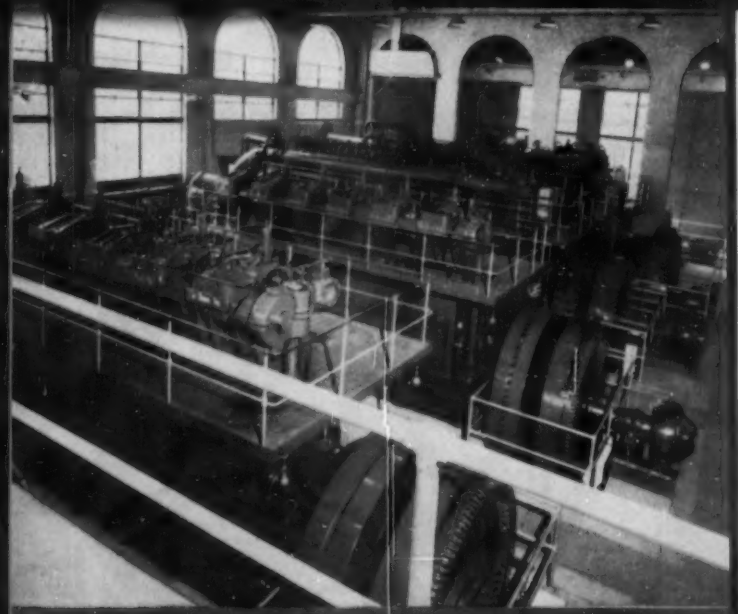
Send for descriptive literature!



WESTERN Precipitation CORPORATION

DESIGNERS AND MANUFACTURERS OF EQUIPMENT FOR COLLECTION OF SUSPENDED MATERIALS FROM GASES & LIQUIDS

Main Offices: 1049 WEST NINTH STREET, LOS ANGELES 15, CALIFORNIA
CHRYSLER BLDG., NEW YORK 17 • 1 N. La SALLE ST. BLDG., CHICAGO 2
1429 PEACHTREE ST. N.E., ATLANTA 5 • HOBART BLDG., SAN FRANCISCO 4
PRECIPITATION CO. OF CANADA, LTD., DOMINION SQ. BLDG., MONTREAL



Maintenance of plant buildings and equipment make this light plant a showplace station of which Pierre residents are justly proud.

What Happens When

STANDARD HD OIL

Is Called In on a Ring Sticking Problem

In 1946, after experiencing considerable trouble with ring sticking, Pierre, S. D., Municipal Light Plant management decided to test STANDARD HD oil in their 2,000 hp. diesel engine. Result: nine years later and after 31,840 hours of operation the original fill of STANDARD HD oil is still in the diesel.

Plant Superintendent Floyd Halbert says engine cleanliness is what he values most. "Cleanliness of the oil is outstanding," he reports and says further, "There is almost no carbon, a minimum of cylinder wall wear and complete freedom from ring sticking. There has never been a bearing failure. Maintenance time for lubrication is zero."

A typical record for STANDARD HD oil? Yes. STANDARD HD is helping many other plants establish new performance records, while setting new levels of engine cleanliness for old engines, and keeping new engines clean from the date of initial fill. Result: more and more folks with industrial lubrication problems like the one at Pierre, call for assistance from their Standard Oil lubrication specialist.

Perhaps you would like to find out more about STANDARD HD. In the midwest, call your nearby Standard Oil lubrication specialist. Or contact, Standard Oil Company, 910 South Michigan Avenue, Chicago 80, Illinois.

STANDARD OIL COMPANY
(Indiana)

STANDARD

In addition to the 2,000 hp. engine, Pierre plant has a 3,000 hp. and two smaller engines. All are lubricated with STANDARD HD Oil. Floyd Halbert (right), and Standard Lubrication Specialist Bob Kirk, go over Pierre plant operation sheet. Bob Kirk is an old hand at helping people solve lubrication problems. He's been doing this for Standard since 1943. Bob got his engineering training from the University of Washington. He has also completed the Standard Oil Sales Engineering School. Customers find this experience and training pay off for them.

CLEAVER-BROOKS SELF-CONTAINED BOILERS HAVE THE FEATURES EVERYONE WANTS!

...which feature would be most important to you?

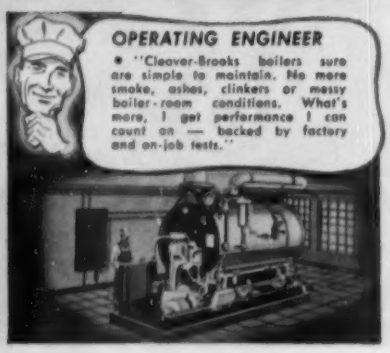
PLANT OWNER
• "Cleaver-Brooks boilers are tops in fuel economy! Forced-draft, four-pass construction and 5 sq. ft. of heating surface per boiler H.P. assure me 80% operating efficiency when firing with oil."

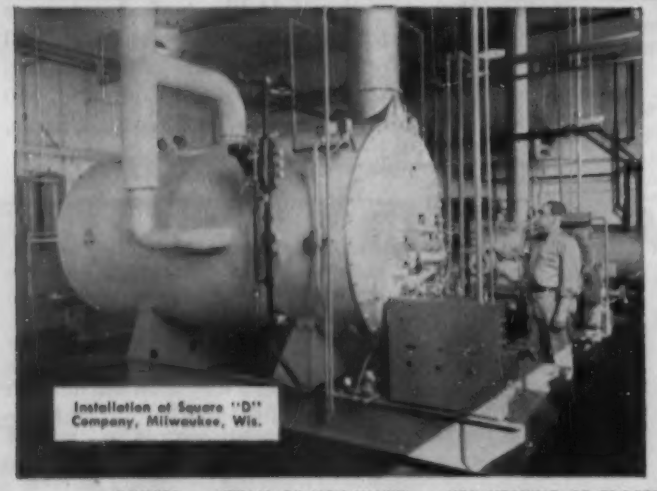
ARCHITECT
• "Self-contained design certainly simplifies boiler room planning — gives owners maximum use from each square foot of space. Gives me flexibility to make best use of low head room conditions."

CONSULTING ENGINEER
• "Oil, gas and combination oil/gas firing lets me recommend Cleaver-Brooks boilers for installation anywhere. Exclusive burner design makes it possible to interchange gas/oil firing in 10 seconds."

CONTRACTOR
• "Boilers are shipped ready to install. With service lines in, my crews have boilers ready for operation in 24 hours or less after delivery. No foundation or stack problems. Cleaver-Brooks furnishes starting service, too."

PLANT SUPERINTENDENT
• "I get all the steam I need for fluctuating steam demands, from full load down to 30% of rating. Automatic burner controls assure instant firing. I call that real dependability."


OPERATING ENGINEER
• "Cleaver-Brooks boilers sure are simple to maintain. No more smoke, ashes, clinkers or messy boiler-room conditions. What's more, I get performance I can count on — backed by factory and on-job tests."


Installation at Square "D" Company, Milwaukee, Wis.

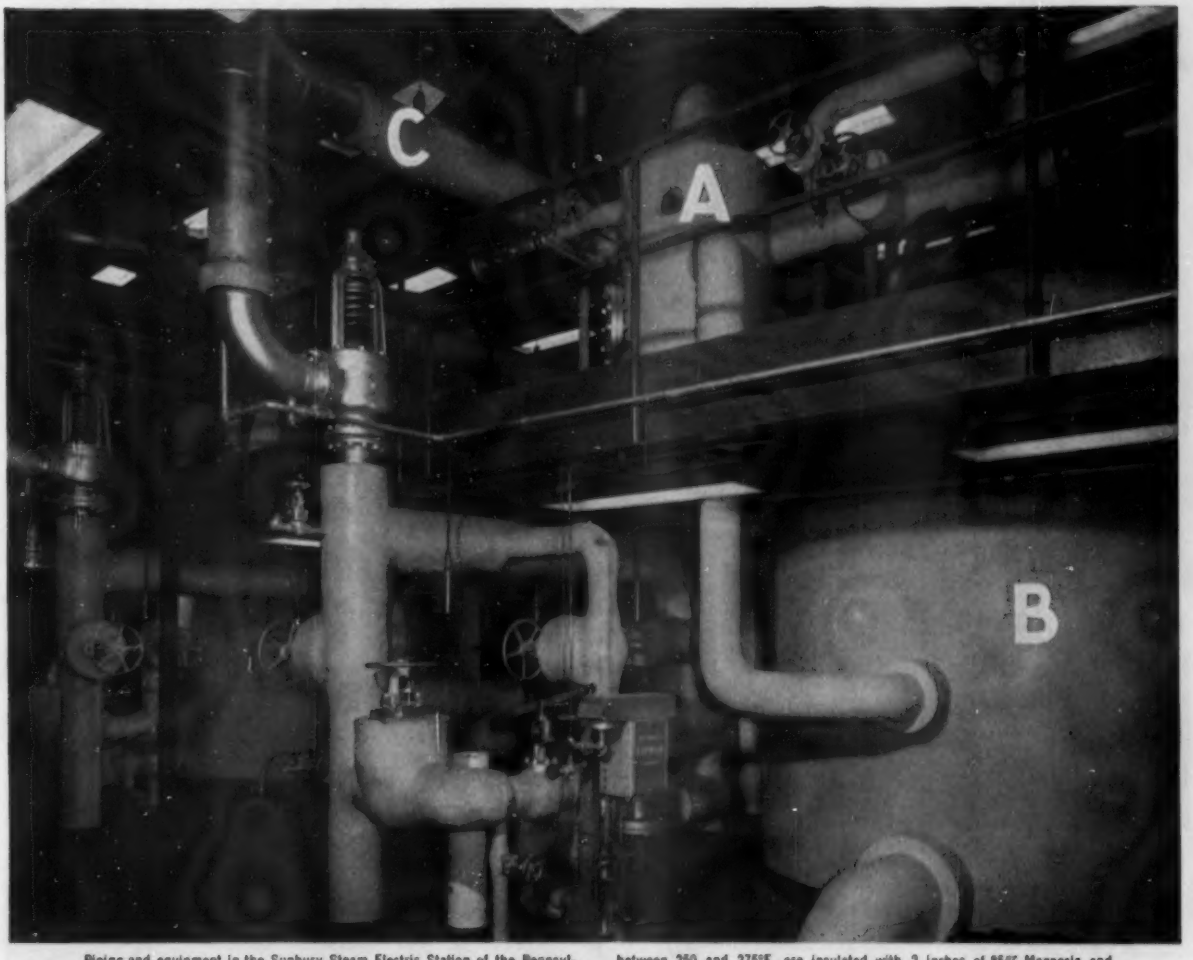
THESE are just a few of the many outstanding features that have made more than 15,000 individual Cleaver-Brooks self-contained boilers *first choice* for commercial, institutional and industrial applications. Get in touch with your nearest Cleaver-Brooks representative for complete facts, or write for catalog AD-100. Cleaver-Brooks Co., Dept. B, 301 E. Keefe Ave., Milwaukee 12, Wis., U.S.A. — *Cable address: CLEBRO — Milwaukee — all codes.*

Cleaver-Brooks

"It's NEW — get the facts on the CB boiler — write today!"

BOILERS — STEAM OR HOT WATER — FOR HEATING OR PROCESSING IN SIZES FROM 15 TO 500 HP, 15 TO 250 PSI.

NOW — FIRST SIZES OF THE CB BOILER ARE MADE IN CANADA, TOO.



Piping and equipment in the Sunbury Steam Electric Station of the Pennsylvania Power & Light Company, insulated with "Featherweight" 85% Magnesia Insulation. The flash tank, "A", and the deaerator, "B", which operate between 250 and 275°F. are insulated with 2 inches of 85% Magnesia and ½ inch of asbestos cement. The piping, indicated at "C", is insulated for the protection of personnel.

K&M "FEATHERWEIGHT" 85% MAGNESIA INSULATION KEEPS OPERATING COSTS DOWN

Plants of almost every type throughout the country have benefited from the use of K&M "Featherweight" 85% Magnesia Insulation. By reducing heat losses, operating efficiency is improved and costs are kept down. Made of 85% basic carbonate of magnesia and asbestos fiber, "Featherweight" effectively insulates piping and equipment with temperatures up to 600°F.

Used with a primary layer of K&M Hy-Temp Insulation (Diatomaceous Silica), the combination is effective up to 1900°F. The application of these two layers—with staggered joints—eliminates the heat loss that normally occurs when expansion causes the joints to open in single layer installations.

Also available is "Featherweight" Water-Resistant Magnesia Insulation for temperatures up to 450°F. It is used underground where severe water exposure may damage the insulation or on indoor steam heated lines and equipment where high humidity and moisture are present.

If your company has an insulating problem, contact your K&M distributor who is an experienced applicator. Or write directly to us.

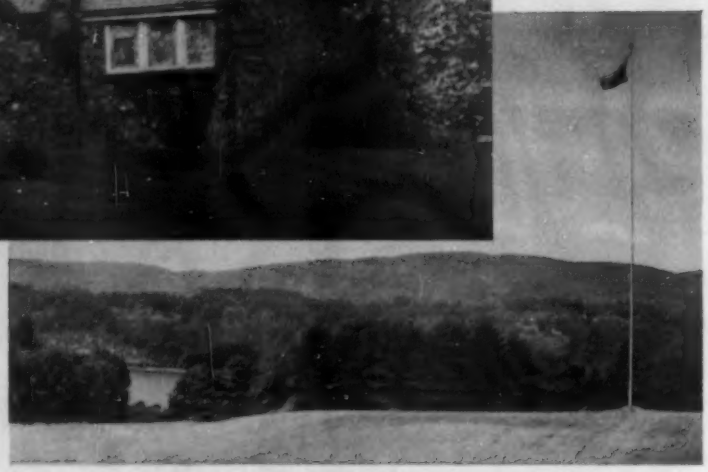
KEASBEY & MATTISON COMPANY • AMBLER • PENNSYLVANIA

Nature made asbestos . . . Keasbey & Mattison has made it serve mankind since 1873

IN CANADA: ATLAS ASBESTOS COMPANY, LTD., MONTREAL, TORONTO, WINNIPEG, VANCOUVER

SMOKELESS OPERATION...

TAYLOR, OF COURSE!



Taylor stokers at the Hudson River State Hospital, Poughkeepsie, N. Y., assure freedom from stack nuisance for this modern institution comprising 80 buildings and 890 beautifully developed and landscaped acres. Pictured above is one of the chapels; at right, a view from steps of the Main Building.

Taylor multiple retort underfeed stokers are today's first choice with state institutions, colleges, hospitals, and heating plants in the heart of cities. This is only natural, for properly engineered Taylor Stokers abolish the stack discharge nuisance once and for all—without costly dust collectors and consequent draft losses!

Furthermore, Taylor's smokeless operation is proof of superior combustion and fuel economy. Wet coals and low grade coals are no problem. Refuse is a desirable by-product instead of an added expense. And Taylor can handle widely varying loads with long-continued low steaming rates ...load variations of 20 to 1 or more are common.

The Taylor Stoker is backed by an organization with reliable service stations in Philadelphia, Dayton and Detroit...Whether your new boiler must deliver 20,000 or 500,000 lbs. of steam per hour, ask your Consulting Engineer about Taylor Stokers. And write us for a copy of free booklet giving full information about Taylor, the completely modern stoker with the old, old name. American Engineering Company, 2400 Aramingo Avenue, Philadelphia 25, Pa.

AMERICAN ENGINEERING COMPANY

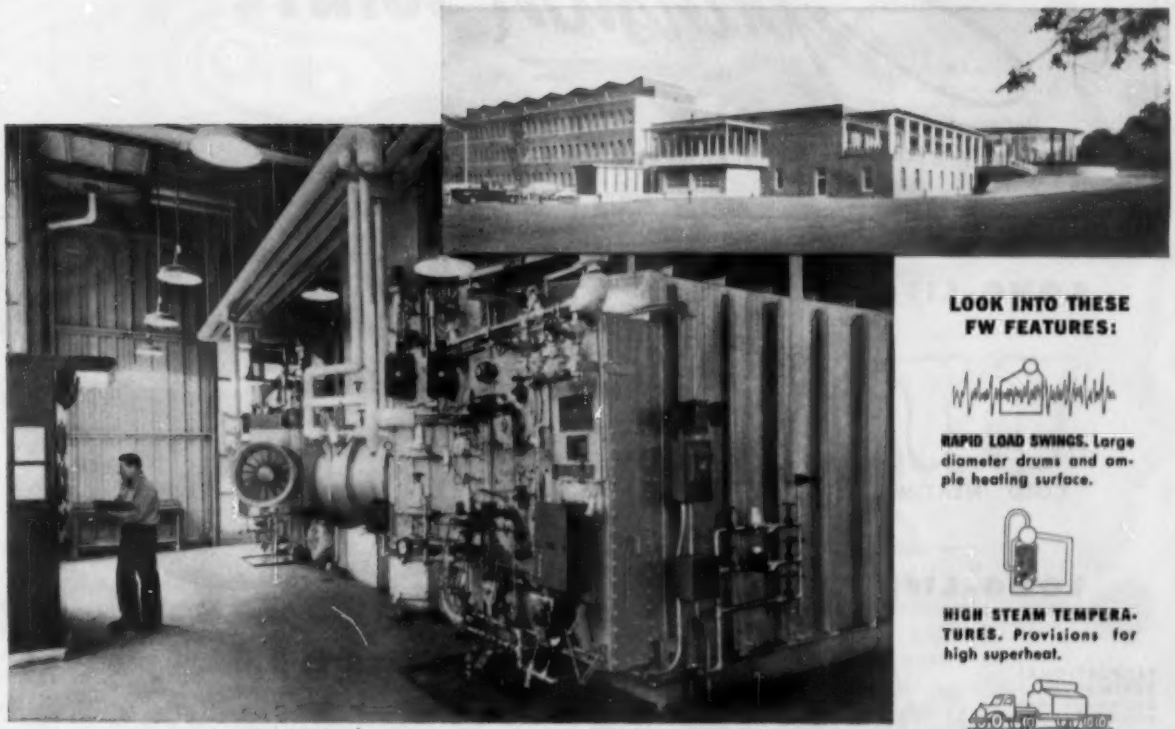
PHILADELPHIA 25, PA.

CANADIAN SUBSIDIARIES: AFFILIATED ENGINEERING CORPORATIONS, LTD., MONTREAL 2, P.Q.: BAWDEN INDUSTRIES LTD., TORONTO 3, ONT.

AE Products are: Taylor and Perfect Spread Stokers, Marine Deck Auxiliaries, Hele-Shaw and Hydramite Fluid Power, Lo-Head Hoists and Car Pullers.

two FW packaged steam generators add up to LOW POWER-PLANT COSTS at new IBM laboratory

TRADE MARK



Two Foster Wheeler 22,000 lb/hr Packaged Steam Generators installed in power plant of new IBM research laboratory at Poughkeepsie, N. Y.

International Business Machines Corporation's new research laboratory at Poughkeepsie, N. Y. is designed for maximum efficiency and dependability of all building services. For low power-plant costs two Foster Wheeler packaged steam generators were chosen.

On actual test, each of these new boilers has produced in excess of the guaranteed capacity of 22,000 lb of steam per hour at 125 psig operating pressure. They will supply the heating load for the entire building, as well as power for the steam-turbine-driven refrigeration plant.

Compared to conventional boiler construction, these standard-design, plant-assembled water tube steam generators effect substantial savings in power plant costs. The high efficiency and easy accessibility of the Foster Wheeler design contribute to low operating and maintenance costs, thus, as in this installation, justifying the use of multiple units.

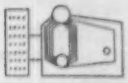
Foster Wheeler Packaged Steam Generators are available in capacities up to 45,000 lb of steam per hour; final steam temperatures to 825 F; pressures to 900 psig. For complete information, write to *Foster Wheeler Corporation, 165 Broadway, New York 6, N. Y.*

LOOK INTO THESE FW FEATURES:

RAPID LOAD SWINGS. Large diameter drums and ample heating surface.

HIGH STEAM TEMPERATURES. Provisions for high superheat.

ADAPTABILITY. Easily moved. Require only a slab foundation — permit outdoor installation.



ECONOMIZERS. Package economizers available to increase capacity and minimize fuel cost.

ACCESSIBILITY. For inspection, cleaning and maintenance.

CLEAN HEATING SURFACES. Soot blowers incorporated . . . cleaning without boiler shutdown.

FOSTER WHEELER

Badger

Expansion JOINTS

Typifying Expansion Joint Engineering at its Best

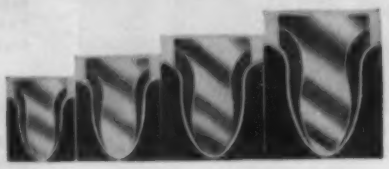
LONG-LIFE FEATURE

COLD HEATING HOT

the ALL-CURVE, directed flexing, corrugation.*

LONG-LIFE FEATURE

PROPORTIONAL DEPTH of corrugation for each range of diameters and traverse.**



Badger Directed Flexing Self-Equalizing Expansion Joints give exceptionally long service life, proof of which has been well established in the City of New York where more than 4,000 of these Badger Joints are installed in the underground steam lines of the largest district heating company in the world.

*** The exclusive all-curve directed flexing corrugations and matching equalizing rings distribute the flexing stresses over the entire area of all corrugations.**

**** For each range of diameters there is a carefully calculated depth of corrugation with a defined limit of traverse.**

Each Badger Expansion Joint is originally designed with the proper number and depth of corrugations for maximum flexibility and service life at full rated traverse.

Remember — when you want long trouble free service in your distribution system, there is no substitute for the proper number and depth of corrugations. COMPARE BEFORE YOU BUY and to be sure you get the best, specify "BADGER".

BADGER MANUFACTURING COMPANY

Original and Sole Manufacturer of Badger Expansion Joints

230 BENT STREET • CAMBRIDGE • MASS.

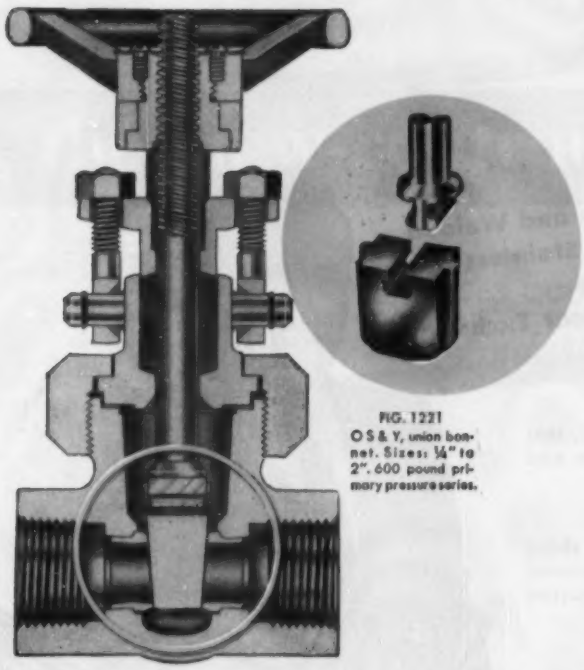


FIG. 1221
O S & Y, union bonnet. Sizes: ¼" to 2". 600 pound primary pressure series.

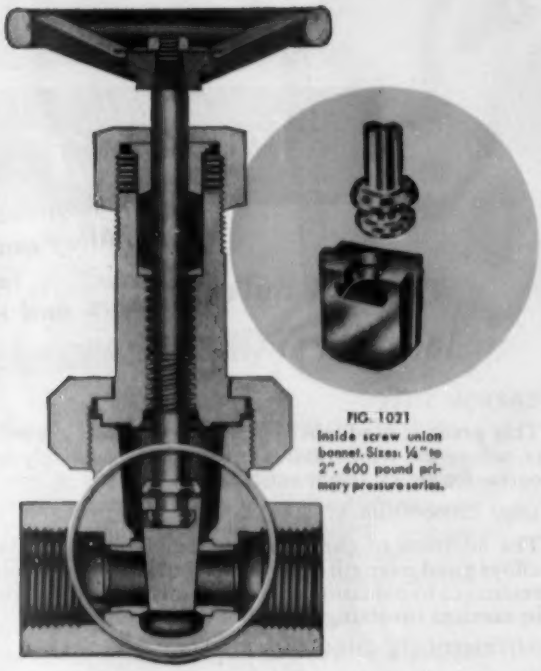


FIG. 1021
Inside screw union bonnet. Sizes: ¼" to 2". 600 pound primary pressure series.

New design makes OIC forged steel gate valves the most modern line . . .

NEW: stronger stem-to-wedge connection. Improved, modern design increases pull-out strength to many times the theoretical requirement. This design distributes the pull-out load more efficiently throughout the wedge structure to meet the most stringent specifications of valve buyers in all fields.

NEW: wedges wear longer. Wedges are made of 13% chrome stainless steel for corrosion resistance. They are duracased to at least 1000 Brinell Hardness to prevent galling and excessive wear caused by frequent closures upon foreign particles in the flow.

NEW: union bonnet design is more efficient. Body-to-bonnet joint of the male-female type provides a recess for the gasket. It is contained more securely, reducing the possibility of leakage or a blown gasket.

OTHER OUTSTANDING FEATURES

Stem threads of all OIC inside screw, forged steel valves are always contained inside the bonnet. They can't possibly load up with corrosive matter which might be in the flow. This keeps the threads clean and free running, and contributes to longer stem wear.

Modern OIC Seal-Ever packing is a special composition which eliminates electrolytic action between the stem and the packing. This prevents stem corrosion in the packing area and helps maintain a leakproof seal.

Back-seating feature provides means of repacking valves while in service.

OS & Y valve gland "I" bolts are retained on trunnions by modern, more efficient, stainless steel snap rings.

Shoulder-type seat rings are expanded into the body under heavy pressure. They are accurately machined to mate tightly with the wedge for a positive seal.

Order modern OIC Forged Steel Valves from your nearby OIC Distributor. Write and request Folder No. 195.

OIC Forged Steel Valves are also available in globes, angles and checks in a variety of trims for any service.

THE OHIO INJECTOR COMPANY • WADSWORTH, OHIO

OIC VALVES | **FORGED & CAST STEEL, LUBRICATED PLUG, BRONZE & IRON**

Meet the Tubes that Meet Your Needs

B&W Seamless and Welded Carbon, Alloy and Stainless Tubing for Condensers and Heat Exchangers

CARBON STEEL

This grade is used where service conditions are mild, that is, where the temperatures involved are relatively low and corrosive attack is not anticipated.

LOW CHROMIUM STEELS

The addition of chromium and molybdenum give these alloys good strength at elevated temperatures and improved resistance to oxidation as well as resistance to deterioration in services involving some hot corrosive gases.

INTERMEDIATE CHROMIUM STEELS

These grades have applications similar to those of the low chromium group except the additional alloying elements improve their characteristics and permit higher operating temperatures. They are particularly adapted to the handling of oils or hydrocarbon fluids containing sulphur compounds.

NICKEL STEELS

These steels are particularly suited for handling neutral salt solutions such as sodium and potassium nitrate or sulphate. They have found service in the black liquor evaporators of soda and kraft paper mills. Another field of application has been in sub-zero temperature service where high impact resistance is also a necessity.

STAINLESS STEELS

These steels are for specialized application where service conditions are extreme, that is, where corrosive environments or high temperatures are problems. The stainless steels have wide usage in the chemical industries, petroleum refinery, paper making, drug preparation, food processing and dairy and beverage industries.

For sound assistance in meeting your specific tubing requirements, write for Bulletin TB-329A or, better yet, get in touch with Mr. Tubes, your link to B&W. He represents B&W's headquarters technical staff and strategically located district offices, and B&W's nationwide network of fine tubing distributors.

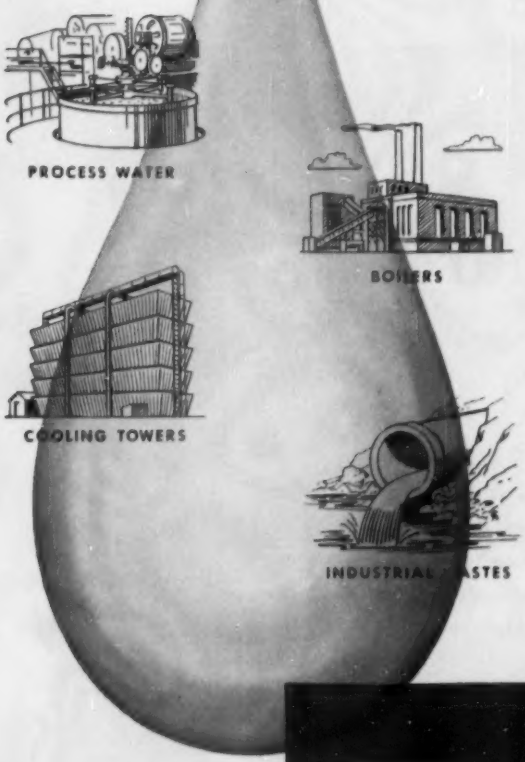
B&W SEAMLESS and WELDED TUBES

THE BABCOCK & WILCOX COMPANY
TUBULAR PRODUCTS DIVISION
Beaver Falls, Pa.—Seamless Tubing; Welded Stainless Steel Tubing
Alliance, Ohio—Welded Carbon Steel Tubing

TA-4044(CWP)

this flow-control approach

provides economical solution to every industrial water treatment problem



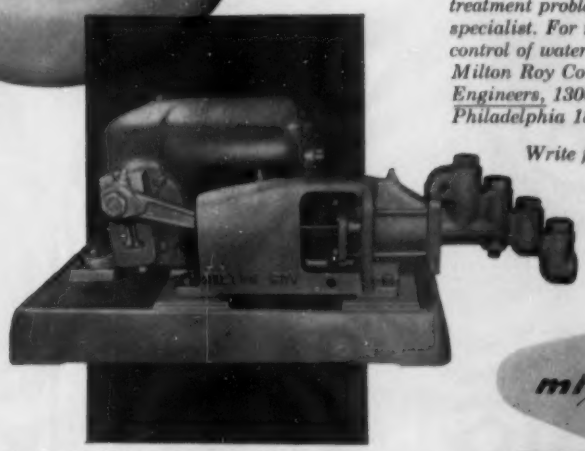
IN PROCESS WATER TREATING SYSTEMS—accurate metering of chemicals assures efficient processing, reduced chemical costs and increased equipment life. Controlled Volume Pumps, or a Milton Roy chemical feed system, provide reliable accuracy in softening, coagulation, demineralization, and other process water treatments.

IN BOILER WATER TREATING SYSTEMS—Controlled Volume Pumps and complete Milton Roy packaged chemical feed systems accurately meter sodium sulfites, phosphates, and caustic . . . to eliminate pitting, scale formation, and boiler corrosion.

COMPARE THE COST of replacing a cooling tower whose wood has delignified . . . of scaled boiler tubes . . . of an off-quality product—with the cost of an efficient Controlled Volume Pump. Can you really afford *not* to invest in Milton Roy precision flow-control?

For specific recommendations on water treatment problems, see your consulting specialist. For reliable, accurate flow control of water treating chemicals, see Milton Roy Company, Manufacturing Engineers, 1300 East Mermaid Lane, Philadelphia 18, Pa.

Write for technical information.



milton Roy
CHEMICAL FEED SYSTEMS

Engineering representatives in the United States, Canada, Mexico, Europe, Asia, South America, and Africa.

THEY WANTED A SINGLE RESPONSIBILITY CONTRACT

The National Petro-Chemicals Corporation wanted a single responsibility contract for the construction of their plant at Tuscola, Illinois.

THEY CHOSE PRITCHARD

The master contract offered by Pritchard assumes full responsibility for engineering, design, drafting and construction. You benefit four ways: 1. You know the total cost before the job begins. 2. You have a firm guarantee of operation and efficiency of the completed plant. 3. You realize great savings from co-ordinated purchase of materials . . . reduction of labor costs . . . uniform control of construction. 4. You realize a faster return on your investment because of earlier completion date.

INDUSTRY'S PARTNER FOR PROGRESS

SERVING THE GAS, POWER, PETROLEUM AND CHEMICAL INDUSTRIES

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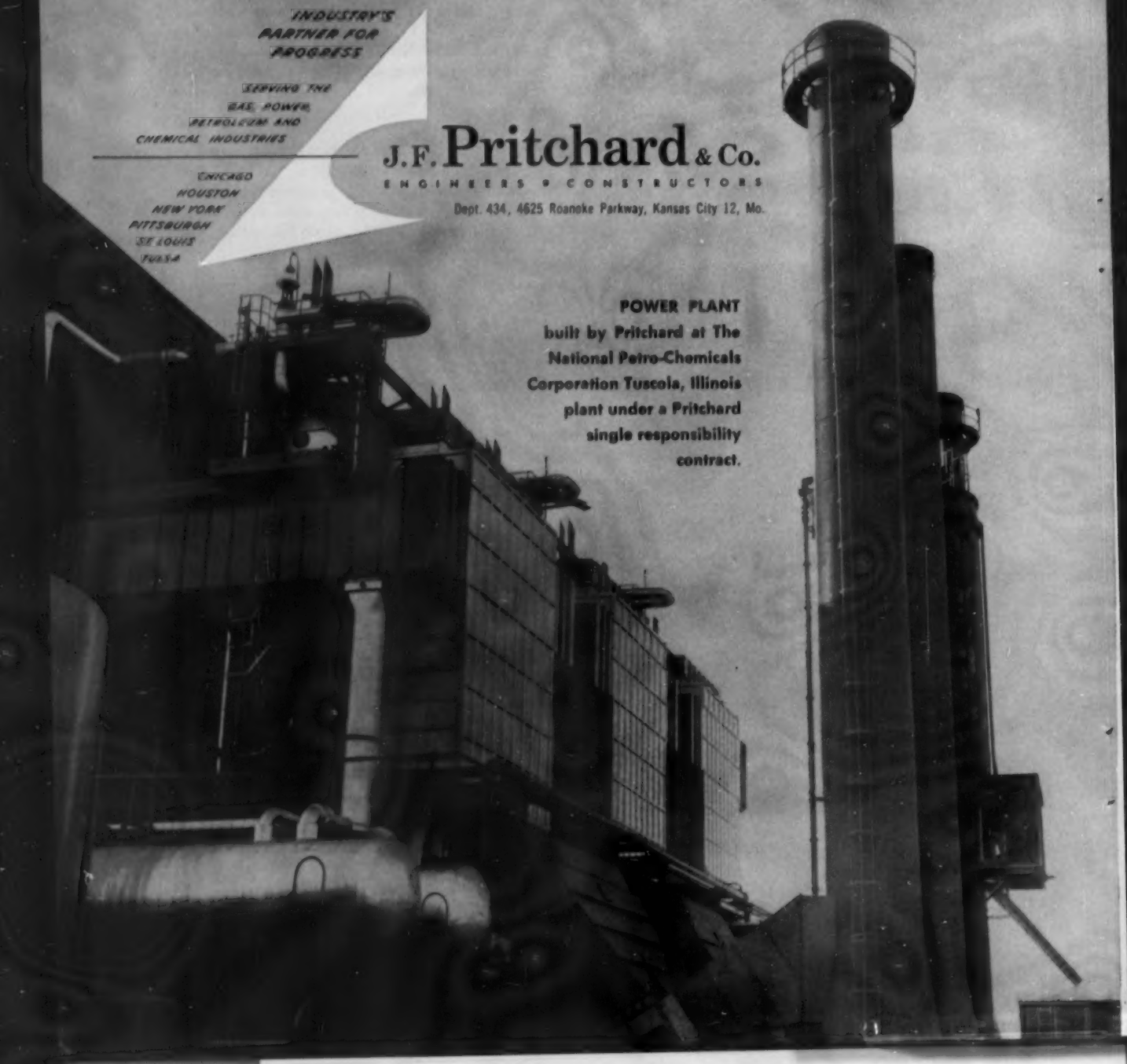
J.F. Pritchard & Co.

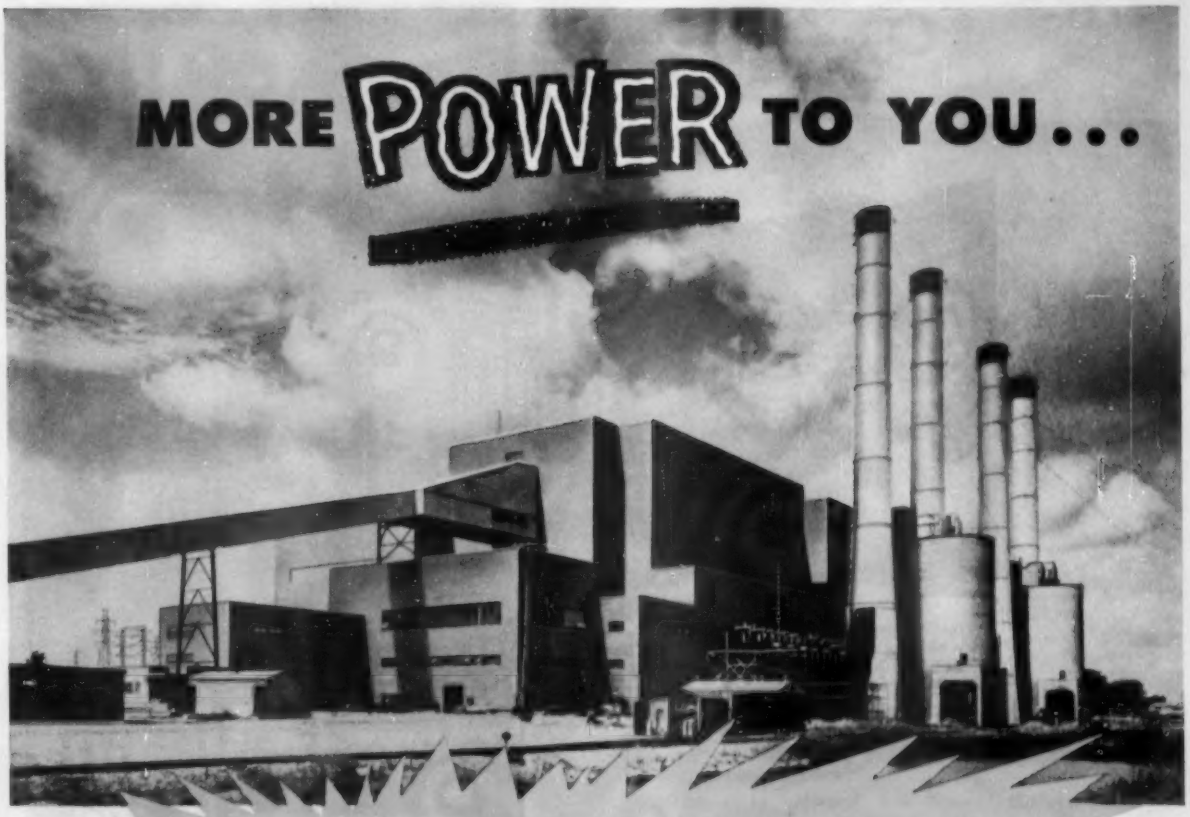
ENGINEERS • CONSTRUCTORS

Dept. 434, 4625 Roanoke Parkway, Kansas City 12, Mo.



POWER PLANT built by Pritchard at The National Petro-Chemicals Corporation Tuscola, Illinois plant under a Pritchard single responsibility contract.

MORE POWER TO YOU...



Detroit Edison Plant boosts U.S. Electrical Capacity to 100,000,000 KW.

Detroit Edison's St. Clair plant boosts U. S. generating capacity to a new high. The last St. Clair unit, rated at 156,250 kw., to go on the line brought the total U. S. electrical capacity to over 100 million kw. Shell Turbo Oil 27 was purchased as the lubricant for this unit as well as for the other three turbine generators in this plant.

Shell Oil Company extends heartiest congratulations to Detroit Edison Company for their part in achieving this industry milestone in electrical power.

Shell is proud of its long association with the great electrical industry.

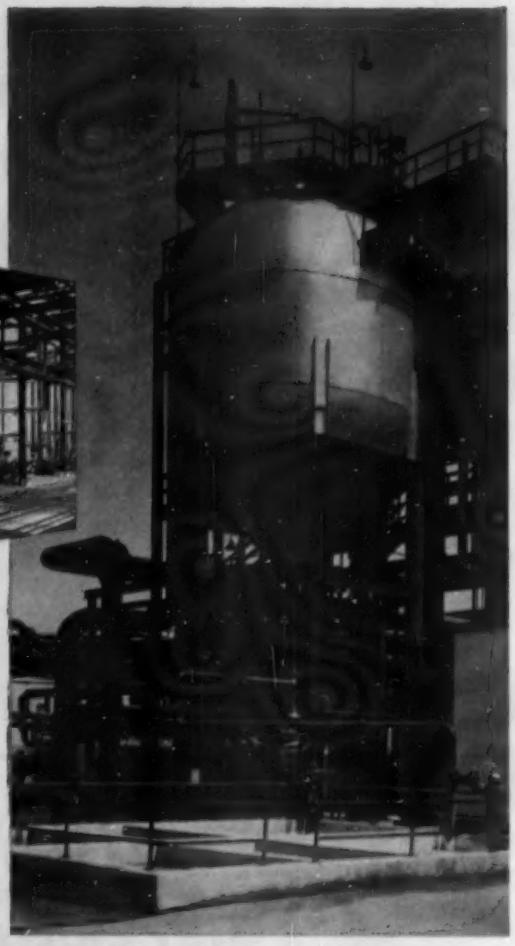
SHELL OIL COMPANY

50 WEST 50TH STREET, NEW YORK 20, NEW YORK
100 BUSH STREET, SAN FRANCISCO 6, CALIFORNIA

SHELL

View of Richfield Oil Corporation's Hot Process Softener installation, first stage in the Hot Lime Zeolite System installed by Cochrane. Capacity 50,000 gpm with tank designed to 26 lbs. code. Structural members are earthquake type supports.

Nine foot diameter filters can be seen in the background. Behind these are the Hot Zeolite Units designed to 150 lbs. ASME code. Other components include supplementary feeds and control panel.



RICHFIELD OIL

again chooses Cochrane

for its Latest Refinery in the West

This Boiler Feedwater Conditioning System is the latest Cochrane installation for Richfield Oil Corporation.

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Cochrane engineers and manufactures every type of ion exchange and precipitation water conditioning equipment. Cochrane is also the pioneer and largest manufacturer of Deaerators in the world. They offer a complete water conditioning service, providing a single responsibility for engineering, fabrication and continued satisfactory operation.

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No Small Blessing

NOT LONG AGO, I dined with a small group honoring Dr Eugen Diesel, son of the great oil-engine pioneer, who was in New York for a few days on the last lap of a world tour. As might be expected among men long interested in the diesel engine, the talk inevitably turned to the life and the work of Rudolph Diesel.

Of the many revealing insights Eugen Diesel gave us, the most interesting to me was his discussion of the motivations that directed his father's genius.

Most of us have read that development of the original diesel engine followed a course different from that of many inventions. It was neither a flash of inspiration nor a lucky accident. The principles of a "perfect" heat engine had been laid down early in the nineteenth century by Carnot. According to common account, Rudolph Diesel consciously set himself the problem of devising an engine that would realize these principles in practice.

Not unsurprisingly, the design he first visualized went through several modifications before it became a working reality. Yet more than most inventions of the nineteenth century, it seems to have been a case of rational development from first principles to successful practice.

What isn't generally known, and what Eugen Diesel made plain, is that the "specification" to which his father worked was vastly broader in significance than the Carnot cycle, basic as that is to all heat engineering.

All his life, said the son, Rudolph Diesel was deeply concerned with social progress. Key to such advance, he believed, was power. He saw clearly the need not only for more efficient power units but particularly for engines that would retain their efficiency in small sizes. This, then, was the fundamental specification to which Rudolph Diesel worked, with human well-being as his paramount concern and constant objective.

Rudolph Diesel didn't live to learn how fully he realized his dream. He did see the diesel engine bring efficient power to communities and industries in all corners of the world. But his sudden death came before the latter-day descendants of his engine brought new concepts of performance to transportation and took on other tasks for which they are uniquely fitted. Truly he built better than he knew.

What is the meaning for us today in this memory of a man who strove for human well-being through progress in power? Simply this: Now, as never before, power is the wellspring of social advance. All of us who play a part in making power cheaper and more plentiful contribute to this advance. It is no small blessing to be able to work toward such a goal in the technical field of our choice.

"The Lower Temperature Rise of FUSETRON FUSES Solved a Serious Shutdown Problem for Us"

J. F. Getz
Chief Engineer,
University of Denver
Denver, Colorado

"The fine, new Field House we built in 1949 included an ice skating rink. The ice making equipment uses two 3 phase, 220 volt, 100 hp., compressor motors having a running current of 246 amperes.

"Ahead of the magnetic starters for these motors were two 400 ampere safety switches originally equipped with 400 ampere renewable fuses.

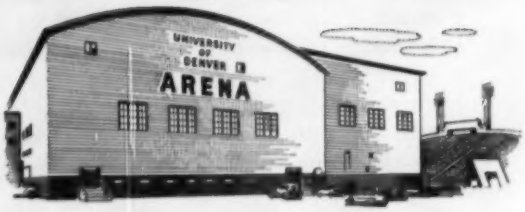
"Shortly after the compressors went into service heat began developing in the safety switches. The fuses were running very hot — in fact to such a degree that the links in the fuses were melting and causing as many as three shutdowns a week.

"In August of 1951 I saw a demonstration by a BUSS representative that showed how much cooler was the operating temperature of Fusetron fuses.

"Right then, I determined to try out Fusetron fuses in these two switches. To get better protection I dropped the fuse size down to 300 amperes.

"With the installation of Fusetron fuses the heating immediately disappeared and so did the shutdowns it formerly caused.

"The lower temperature rise of Fusetron fuses solved a serious shutdown problem for us."



YOU TOO, CAN MINIMIZE PLANT SHUTDOWNS AND EQUIPMENT LOSSES BY INSTALLING FUSETRON FUSES — THEY GIVE 10 POINT PROTECTION

1 Protect against short-circuits. **2** Protect against needless blows caused by harmless overloads. **3** Protect against needless blows caused by excessive heating — lesser resistance results in cooler operation. **4** Provide thermal protection — for panels and switches against damage from heating due to poor contact. **5** Protect motors against burnout from overloading. **6** Protect motors against burnout due to single phasing. **7** Give DOUBLE burnout protection to large motors — without extra cost. **8** Make protection of small motors simple and inexpensive. **9** Protect against waste of space and money — permit use of proper size switches and panels. **10** Protect coils, transformers and solenoids against burnout.

And with FUSETRON FUSES you have Greater Safety, because of their 100,000 amp., Interrupting Capacity Rating

Tests verified by the Electrical Testing Laboratories of New York show that Fusetron fuses, on loads under 600 amperes, can interrupt safely the most severe available short circuit currents.

The test circuits were set to deliver far in excess of 100,000 amperes — yet the 250 and 600 volt Fusetron fuses on each and every test cleared the circuit without igniting readily flammable material placed around the fuses . . . and there was comparatively little noise.

You get all this added safety for every set of fuse clips in your plant without changing a panelboard or switch

No Interference with time-lag

Fusetron fuses' time-current characteristic, of the utmost importance to give proper motor and electrical protection and to eliminate needless blows, has in no way been disturbed.

For High Interrupting Capacity above 600 and up to 5000 amps. — Install BUSS Hi-Cap Fuses

BUSS Hi-Cap fuses offer unlimited interrupting capacity for circuits of 600 volts or less. Their high speed operation on heavy shorts limits current to safe values. This minimizes damage to equipment and cuts down dangerous stresses on transformers.

When coordinated properly with Fusetron fuses they will not open ahead of the fuse nearest to the fault—thus the trouble is isolated to the part of the circuit in which the fault occurs.

Added Safety on Old Installations

On installations where the increase in the capacity of the circuit has outgrown the interrupting rating of the circuit breakers, BUSS Hi-Cap fuses offer a safe and relatively inexpensive way to protect inadequate breakers against rupture in event of a bad fault.

Maximum Safety

With Fusetron fuses there is no cascading of interrupting rating — no places where an excessive fault current might cause serious damage. Every Fusetron fuse has an interrupting rating in excess of 100,000 amperes.

You don't have to worry about selecting chosen spots in which to pay extra for "safe" equipment. Wherever a Fusetron fuse is installed you have safety as sure and dependable as you can buy — no matter what you pay.

No Maintenance Costs

Once properly installed Fusetron fuses are maintenance free. They require no costly inspection or down-time for calibration and other maintenance necessary on mechanically operated devices.

Dust, fumes, corrosion or age cannot prevent a Fusetron fuse from opening safely. There are no hinges, pivots or contacts to stick or slow down the operation of the fuse on short-circuit.

No Recalibration Costs

When a Fusetron fuse does blow, there is no recalibration needed. As quickly as the fault in the circuit is corrected, you slip in a new fuse that has been CALIBRATED AT THE FACTORY BY ENGINEERS — a fuse that is as safe and dependable as the one that blew.

PLAY SAFE—Install FUSETRON Dual-Element Fuses and BUSS Hi-Cap Fuses throughout the entire electrical system . . . Today!

One needless shutdown . . . one lost motor . . . one destroyed switch or panel . . . one burned out solenoid . . . may cost you far more than replacing every ordinary fuse with a Fusetron fuse on loads up to 600 amps — and BUSS Hi-Cap fuses on loads above that.

Blowing time charts and more information are available. Write for bulletins FIS and HCS.

FUSETRON
TRUSTWORTHY NAMES IN ELECTRICAL PROTECTION
BUSS

BUSSMANN Mfg. Co.
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Please send me complete facts about FUSETRON dual-element Fuses and BUSS Hi-Cap Fuses.

*Name*_____

*Title*_____

*Company*_____

*Address*_____

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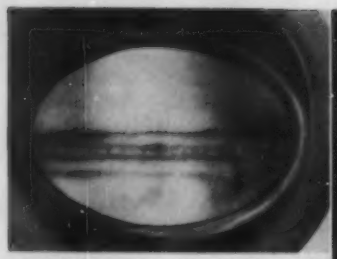
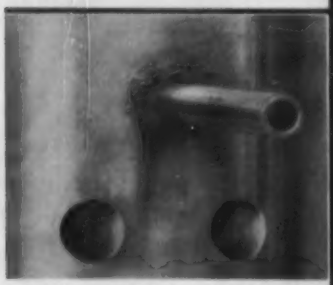
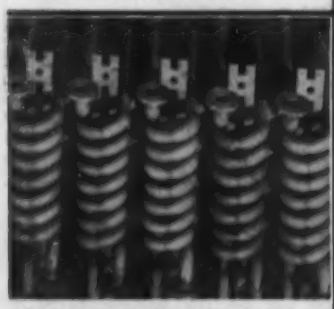


Typically smooth, uniform inside bead in stainless steel piping which results from making root pass with PP&E "free flow" inert gas shielded tungsten arc-welding process.



Stainless steel thin wall tubing is soundly welded to heavy stainless steel body by a skillful PP&E inert gas tungsten arc-welder.

Smooth external surfaces of welds on this component are the result of long experience in welding stainless steels.



Condenser coils of stainless steel, completely prefabricated at Pittsburgh Piping and Equipment Company.

Sound, clean joint having uniform root bead of correct internal contour is result of Pittsburgh Piping's tungsten arc-weld process which provides "free flow" of inert gas on internal and external surfaces of root pass.

EXPERT FABRICATION of Stainless Piping FOR POWER OR PROCESS

At PP&E we have been fabricating stainless steel piping since the middle 1920's . . . extended experience which is unsurpassed by any other power piping fabricator. The importance of this experience, to you, is its great value in avoiding errors in omission and commission which can result in inefficiency, damage to expensive equipment, and dangerous operating conditions. Consult our nearest representative for further information.

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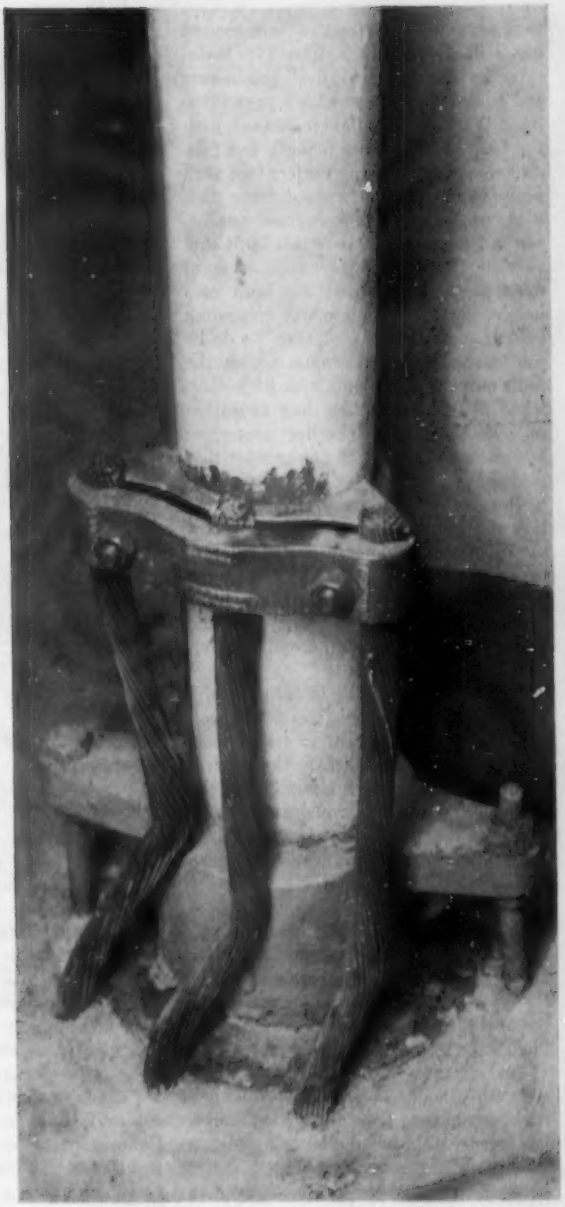
Power
FEBRUARY 1955

Equipment grounding:

Is it really protecting your plant?

By R H KAUFMANN
Industrial Engineering Section
General Electric Company



- A heavy bonding system to structural steel and water pipes may be giving you a false sense of security
- Tests prove major chunk of ground-fault currents tend to return on the power conduit or on grounding cable within such conduits
- As a result you may see some changes in Article 250 (section on equipment grounding) in next edition of the National Electrical Code

Now turn page for details

► EFFECTIVE EQUIPMENT GROUNDING has a dual function in life: (1) Maintains voltage between "live" conductors and equipment frames within preset limits. (2) Provides a low-resistance path for fault-current flow. When a live conductor accidentally makes contact with grounded equipment, a conducting path is set up between the energized conductor and ground. It is over this fault connection that the heavy fault current must flow. Once across the fault connection, layout of equipment grounding system comes into the picture. To do its job, grounding circuit must accept the fault current safely and with little electrical disturbance other than operation of ground relays or other protective equipment placed in the circuit for that purpose.

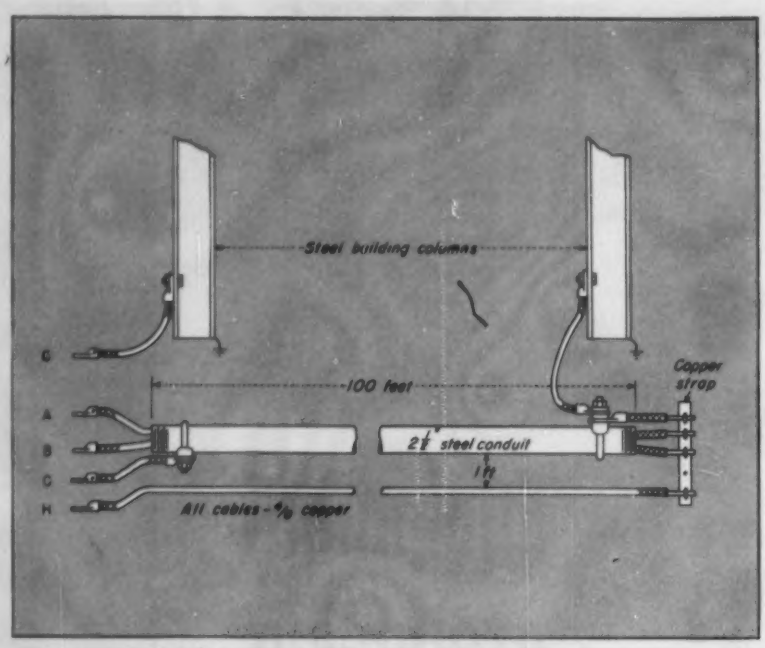
The problem. Flow of fault current into the grounding circuit may present two distinct problems: (1) production of arcs or undue heating developing a fire hazard (2) building of a voltage difference between exposed metallic members of the building, creating a personnel shock hazard.

With a conventionally installed equipment grounding system, you might well expect the fault current to take a beeline back to the spot where the neutral or phase is purposely grounded in the primary or secondary transformers. This is true in dc circuits after a steady-state condition develops. However, it is not so in ac systems.

In ac, reactance of the ground-return path serves as a sizable block to the flow of current, which is just as active as circuit resistance. *Here's the key thought:* A circuit has lower reactance if the return current path closely parallels the outgoing power cables.

Past practice. Photos, pp 77, 80, show common practice in grounding the electrical equipment frames to heavy building structural members using large grounding cables. This was generally believed to provide a low-resistance grounding system over which heavy ground-fault currents could flow quite easily and with low voltage-drop. True, it is a low-resistance path, but high reactance may prevent any sizable proportion of the fault current from seeking this path of return since it is widely separated from the outgoing power circuit. A major portion of the fault current would probably elect to flow over the metal conduits and raceways since they generally constitute a closely spaced return path.

Carefully run tests show a strong tendency for the return current to hug the outgoing power conductors. These tests, *see sketches,* confirm theoretical predictions made prior to lab work.



'We used this test setup to get...

Under a short circuit to ground condition in any ac distribution circuit, grounded and ungrounded systems alike, inductive reactance exerts a powerful influence in directing the return current to flow in a path closely paralleling the outgoing power conductor. The enclosing conduit or metallic raceway constitutes such a path.

Tests prove that attempting to relieve the conductor enclosure by installing an external conductor is quite ineffective. Connections to nearby building structural members are equally ineffective. Only by using an internal grounding conductor can current in the enclosure be noticeably reduced. Joints in conduit or raceway need special attention to avoid a shower of sparks if a full ground occurs. Any thought of keeping the conduit or raceway insulated from ground except at one point seems impractical.

Test setup, above, was about 5 ft from a row of heavy steel building columns. A 100-ft run of 2½-in. heavy-wall steel conduit was placed on post insulators. These insulators prevented current-transfer to or from conduit at intermediate points along its length. Two 4/0 conductors were pulled within the conduit. Then about 1 ft from conduit, on the side opposite the building columns, another 4/0 conductor was placed paralleling the conduit. All building columns were interconnected through a heavy ground cable network beneath the floor.

Measured dc resistance between building columns adjacent to conduit ends was about 1/50 that of the conduit. Incidentally, dc resistance of the 4/0 cable was about equal to that of the 2½-in. steel conduit.

Test installation was made to examine a wide number of current paths in sequence. How the terminal lugs were connected controlled the permissible current paths during any one test. The 60-cycle test current was always carried out over a copper cable within the conduit right to the far end. Return path consisted of any one of a variety of possible circuits in the grounding system to simulate different conditions. Each time a measurement of the current division in alternate paths was made.

One test series was made at 200 to 400 amp, using a welding transformer as the current supply. Current could be maintained for long periods while readings were taken with indicating instruments. Second test series was at high current, using a 500-kva transformer as the power source. In these tests currents were about 10,000 amp, simulating prac-

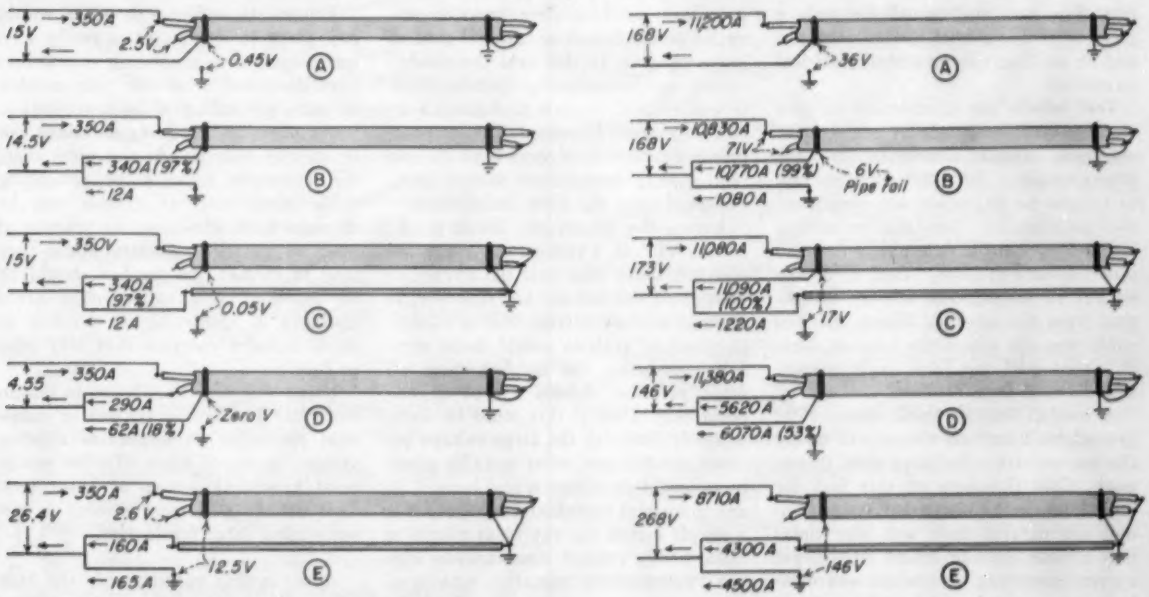
(*Continued on page* 80)

Ground-current values using a variety of circuit arrangements

Current tests	Current flow: Out on	Current flow: Return on	Current magnitudes: I_A total	I_C: Amp	I_C: % total	I_B	I_H	I_G	Voltage magnitudes: E_{AC}	E_{CG}	E_{AB}	E_{AH}	E_{AG}	E_{BG}
LOW	A	B	350	0		350	0	0	2.47		4.85			
	A	C	350	350	100	0	0	0	15.9	0.45	2.5			
			200	200	100	0	0	0	9.05	0.15	1.51			
	A	CH	350	340	97	0	12	0	16.0	0.05	2.55			
			200	190	95	0	8	0	9.13		1.55			
	A	CG	350	340	97	0	0	12	14.6		2.54	14.4		
			200	180	90	0	0	8	9.5		1.50	9.4		
	A	CB	350	62	18	290	0	0	4.55		4.55			
			200	40	20	150	0	0	2.68		2.68			
	A	GH	350	0	0	0	160	160	14.0	12.5	2.5	26.4	26.4	24.1
			200	0	0	0	98	98	9.2	8.1	1.5	17.1	17.1	15.6
HIGH	A	C	11,200	11,200	100	0	0	0	168	36*				
			11,070	11,070	100	0	0	0	173	38*				
	A	CH	11,000	11,200	101	0	1,140	0	173	18*				
			11,080	11,090	100	0	1,220	0	173	17*				
	A	CG	10,830	10,770	99	0	0	1,080	168		71			
			10,910	10,780	99	0	0	1,145	173	9*				
	A	CB	11,620	5,810	50	5,660	0	0		27*			155	
			11,380	6,070	53	5,620	0	0	146	25*				
	A	GH	8,710	0	0	0	4,300	4,500		146*			268	

*Distorted wave shape; tabulated values are crest ÷ $\sqrt{2}$

...these results, pinning down ground-current paths'



Low-current tests used 200-400 amp

First series of tests were made using a low current, falling between 200 and 400 amperes. A welding transformer was the supply source. In both the low- and high-current tests, the 60-cycle test current was caused to flow out over one of the internal copper cables to the far end returning over various paths.

About 10,000 amp: high-current runs

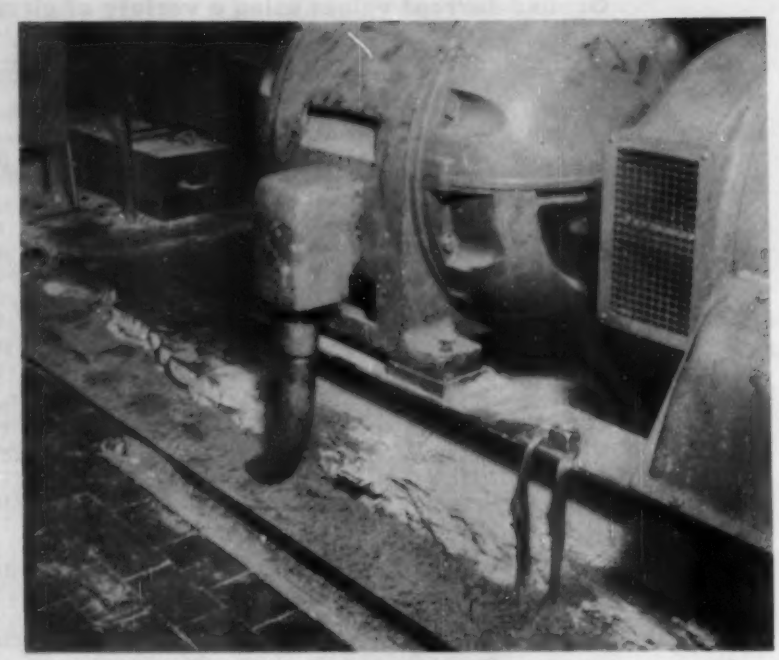
A 500-kva power transformer was the supply source for the high-current tests with current magnitudes of about 10,000 amp. Aim here was to simulate practical short-circuit conditions as they would exist in service. Current was maintained for fraction of a second during each test; an oscillograph measured quantities.

Some highlights of the test

- **In spite of the extremely low resistance of building structural frame, it failed to reduce magnitude of current in the conduit**

- **First high-current test produced a shower of sparks from about half the couplings in conduit run. A blowtorch stream of sparks came from one, burning away many of the threads. Crew who installed the conduit vouched for coupling's tightness**

- **During one high-current test, a spray of sparks was noticed at a building column. They originated at a spot where a water pipe passed through an opening cut in web of the steel beam involved. Pipe had been in loose contact with edges of the hole**



TYPICAL GROUNDING SETUP in wide use today. Tests show major portion of any ground-fault current tends to return on the conduit feeding the motor-generator set

'A more effective grounding system can now be had at lower cost'

tical short-circuit conditions. Here current flow was maintained for only a fraction of one second during each test and an oscillograph measured electrical quantities.

Test results are summarized on previous page in both tabular and graphical form. *Results clearly indicate the strong tendency for return fault current to remain on or within the conductor-enclosing-conduit.* Note that connecting a 4/0 copper cable external to the conduit (about 1 ft away), *Case C*, diverted but an insignificant amount of current from the conduit. Where the 4/0 cable was run within the conduit, *Case D*, about half the total fault current was diverted from conduit.

Actually, but a small amount of ground fault current was picked up by the low-resistance building steel framework. *Case B* points up this fact for both high- and low-current tests. Conduit circuit resistance was may times that of the building frame circuit, yet current returning on conduit was within a few percent of total short-circuit current. It all boils down to one simple fact: *Cable connections to building steel framework impart a false sense of grounding adequacy.*

Why? Test conditions, *Case E*, for both high- and low-current runs are definite proof of the powerful forces present to produce the current concentration on conduit or on internal grounding conductor. In this case the conduit circuit was intentionally open-circuited. It was evident at once that ground-circuit impedance increased. This increase meant a reduction of more than 25% in total ground short-circuit current being delivered from the 600v transformer.

Across the intentional break in the conduit circuit, a voltage was measured equaling more than half the impressed voltage on the test circuit. However, to attempt to block current flow on conduit in practical systems would mean carefully insulating the conduit from all other metallic objects except at one point only. Even if this could be done, which is doubtful, the large voltage between conduit and other metallic structures would constitute a real hazard. In any industrial manufacturing area, it is a simple matter for any plant people to make bodily contact simultaneous with two independent metallic structural members.

Photo, above, shows a typical method of applying an independent equipment ground. But recent studies reveal that for an effective equipment grounding system the conduit itself must be highly conductive, possibly augmented with a grounding cable within the conduit.

Future. As progress is made within any plant in developing a really adequate equipment grounding system that parallels power conductor runs, number of heavy grounding cables connecting to water pipes and building structure can be greatly reduced. At the same time, the extensive network of grounding cable often used at present can be trimmed back. However, the practice of bonding metallic members where they tend to contact one another should be continued. This practice helps avoid sparking or sputtering as a result of small transfer currents that may tend to flow.

Using this new knowledge to design electrical distribution systems in industrial plants or to modernize existing systems means a more effective equipment grounding system at lower cost. This will be still more evident in circuits using large conductors.

Above article outlines only the high points. For a more theoretical treatment see two AIEE papers: "Some Fundamentals of Equipment Grounding Circuit Design," by R H Kaufmann, AIEE 54-244, and "Iron Conduit Impedance Effects in Ground Circuit Systems," by A J Bisson, AIEE 54-36.

How to submit entries

1. Entries will be received from plants of any type, of any size, in any service, in which a modernization program was completed during the calendar year 1953 or 1954. Modernization may cover the entire power-service installation or any major part of it.

2. Entries may be made by any responsible member of a plant's power-service staff, or by a consultant for his client.

3. To enter, just say "I'd like a 1955 Modernization Award blank" and address your card or note to:

Modernization Award Committee
c/o POWER
McGraw-Hill Publishing Co, Inc
330 West 42nd Street
New York 36, N. Y.

4. The entry blank you receive will contain a series of streamlined questions designed to make it easy for you to tell us about your modernization job and its results.

5. In general, the kind of information we ask for will tell us (1) what was modernized (2) the principal reasons for modernization (3) what results were obtained (4) the unique features of the job, and (5) what unusual or difficult problems were solved.

6. Entries will be accepted to May 15, 1955.

7. Announcement of award winners will be made in the 1955 Mid-September *Modern Plant* issue.

8. Arrangements for presentation of the awards will be made to suit the mutual convenience of the recipients and the POWER staff.

9. There is no set number of awards. It is our intention to recognize all plants that, in the opinion of the judges, have carried out modernizations of outstanding merit.

Will you be in the 1955 award picture?

You can be, if you completed a modernization in 1953 or 1954, and if you follow the simple entry procedure outlined at the left.

Last year, 18 plants received recognition for modernization accomplishments that racked up annual savings of more than $3 million. Pictured above is the presentation of one of these citations, to Columbia-Southern Chemical Corp. Howie Kallen, asst editor of POWER, congratulates M W Jones, asst to the supt of maintenance and engineering, who submitted the award-winning entry. Looking on is W S Straub, works manager.

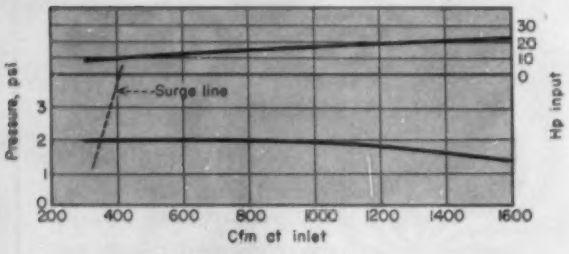
Scenes like this will be duplicated in other plants across the country after the 1955 Modernization Awards have been announced in the Mid-September *Modern Plant* issue. And, like "Mike" Jones, other engineers will have their initiative and ability recognized, their plants will proudly display modernization citations.

But—and this is a big *but*—you can't have your accomplishments considered for an award unless you tell us about them. For that purpose, we've set up a streamlined entry procedure. Read about it in the left-hand column, ask for your entry blank now.

Remember, entries may be made for any type of plant —steam, diesel or hydro—in any service—industry, institution or utility. Modernization may involve the entire power-service system, or any major part of it. Small projects will receive same consideration as large.

Centrifugal blower

By FRANK H BOND, *Engineer*
United States Hoffman Machinery Corp



Flat performance curve

Design guide to low-cost air supply

► THE USUAL compressed-air system operating at 80 to 120 psig is designed to deliver air to tools and other devices requiring pressures in this range. But using air at these pressures for blowing chips, dust and other particles from machine surfaces can waste power or endanger personnel.

Power input. Nozzles for air in the 100-psig range usually have a 1/16-in.-diameter outlet because larger sizes cause too much pressure loss in the system. Also, the 1/16-in. nozzle is the most readily available size with a dependable shutoff valve.

When supplied air at about 100 psig and discharging to a room at atmospheric pressure, these nozzles have a throat velocity equal to that of the speed of sound in air, or about 1125 ft per sec. This is the critical velocity and cannot be exceeded no matter how high the inlet pressure is raised. So any work done to compress the air above a certain optimum pressure is wasted, so far as throat velocity at the nozzle is concerned.

Using low-pressure air, in the 1.5-psig range, a more effective blowing job can be done with much less power input to increase the air pressure. By using a separate centrifugal blower, power is saved and the main air system is relieved of the blowing load, making more air available for tools and other devices.

Safety. High-pressure air for chip blowing can also be extremely dangerous. Playful use of nozzles may cause serious injury, while flying chips, dust and dirt are hazardous to both men and machines. In recent years, several states have revised their codes, forbidding high-pressure air for blowing.

Tests in one Western state showed 7-psig air is not injurious to the human ear drum. Use of this or a lower pressure is often recommended for routine blowing of dust and dirt.

Comparison. Our test and field experience shows that a number of equations, based on usual nozzle and air-jet principles, are useful in evaluating the relative performance of high- and low-pressure nozzles. They are also valuable during plant design, or while making checks of an existing installation. Though purists might argue with some of the assumptions and approximations, our experience confirms their practical accuracy. Let's see how they're applied.

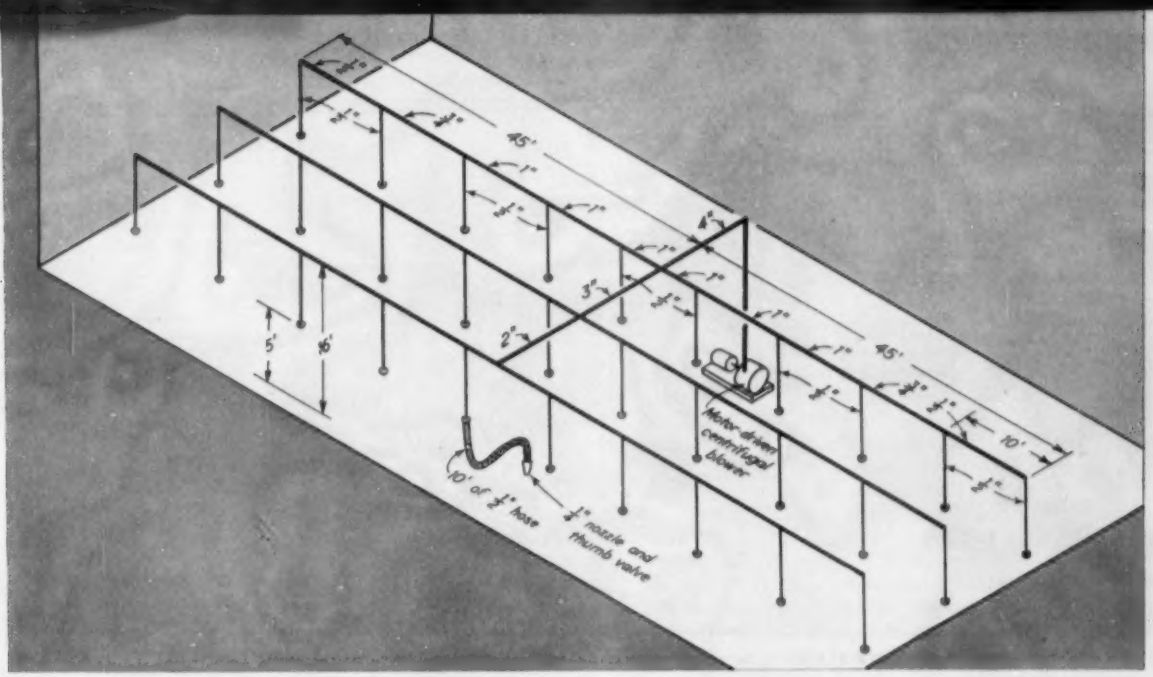
Example: What air velocity is obtained 4 in. from the outlet of a 1/16-in.-diameter nozzle supplied air at 35 psig? How much air is discharged by this nozzle?

Solution: Axial velocity at a distance, x in. from a nozzle, is given by $V_x = (8.4V_o)/(x/D + 2)$, where V_x = axial velocity at point x, ft per min; V_o = axial velocity at nozzle outlet, ft per min; D = jet diameter, in. Axial velocity at the nozzle throat is obtained from $V_o = 21{,}094\sqrt{P}$, where P = nozzle inlet pressure, psig. Quantity of air discharged by the nozzle is given by $Q = 69D^2(\sqrt{P})$, where Q = air discharged, cfm; other symbol as before.

Computing the axial velocity at the nozzle throat, $V_o = 21{,}094\sqrt{35} = 125{,}000$ ft per min. This equation, however, is not valid when the nozzle inlet pressure is greater than the critical. For air at 500 F or less, the critical pressure, P_c psia $= 0.53\ (P + 14.7)$ at sea level. Hence, $P_c = 0.53\ (35 + 14.7) = 26.3$ psia, or 11.6 psig when the inlet pressure is 35 psig.

Maximum velocity attained at throat of this nozzle is equal to the critical velocity, or 1125 ft per sec when atmospheric temperature is 68 F and the nozzle is at sea level with a 14.7-psia atmospheric pressure.

At a distance of 4 in. from the nozzle outlet, the axial velocity $V_x = (1125)\ (60)\ (8.4)/(4/.0625 + 2) = 8591$ ft



Typical piping system for blowing

for industrial dirt-blowing systems

per min. This is the velocity available to move dust, dirt and other particles from a surface served by the blowing apparatus.

Quantity of air discharged is $Q = 69\,(1/16)^2(\sqrt{35}) = 1.6$ cfm. Assuming the air weighs 0.075 lb per cu ft, weight discharged is $1.6\,(0.075) = 0.12$ lb per min.

Low-pressure air. Now let's see what effect can be produced by a 2-stage centrifugal blower discharging at 2 psig over a wide pressure range. We'll allow a 0.5-psig pressure drop through the hose and piping, giving a 1.5-psig nozzle-inlet pressure.

We can see that the quantity of air discharged, $Q = 69D^2(\sqrt{P})$, will be extremely small if a 1/16-in.-diameter nozzle is used at a pressure of 1.5 psig. So for low-pressure air any nozzle must be larger than for high-pressure air. But at the same time, the nozzle must be small enough so it and its hose are easily handled by the operator.

A ¼-in. nozzle will be chosen because this size is easily used and takes advantage of the flat performance curve of a centrifugal blower. It is desirable to choose a nozzle size that requires the minimum number of stages possible.

Axial velocity at nozzle outlet is $21{,}094\sqrt{1.5} = 25{,}900$ ft per min. Velocity at a point 4 in. from the nozzle outlet $= (25{,}900)\,(8.4)/(4/¼ + 2) = 12{,}087$ ft per min. Quantity of air discharged $= 69\,(¼)^2\sqrt{1.5} = 5.28$ cfm, or 0.396 lb per min.

Results. Now let's see how these two methods of supplying air for blowing purposes compare. If our installation is to have 10 blowing stations, total quantity of 35-psig air required is $10(1.6) = 16$ cfm. A single-stage compressor rated at 19.5 cfm at 50 psi requires a 3-hp drive. But if the air is supplied at the usual 100 psi and reduced to 35 psi, a 5-hp drive delivering 18.3 cfm is needed.

A standard centrifugal blower supplying 52.8 cfm to 10 stations requires 1.1 hp. This is 22% of the power required for 100-psi air, 37% of that for 50-psi air. In the first case, we have a power saving of 78%; in the second, 63%. Experience shows the blowing effect obtained with the low-pressure arrangement is just as good as with either high-pressure hookup.

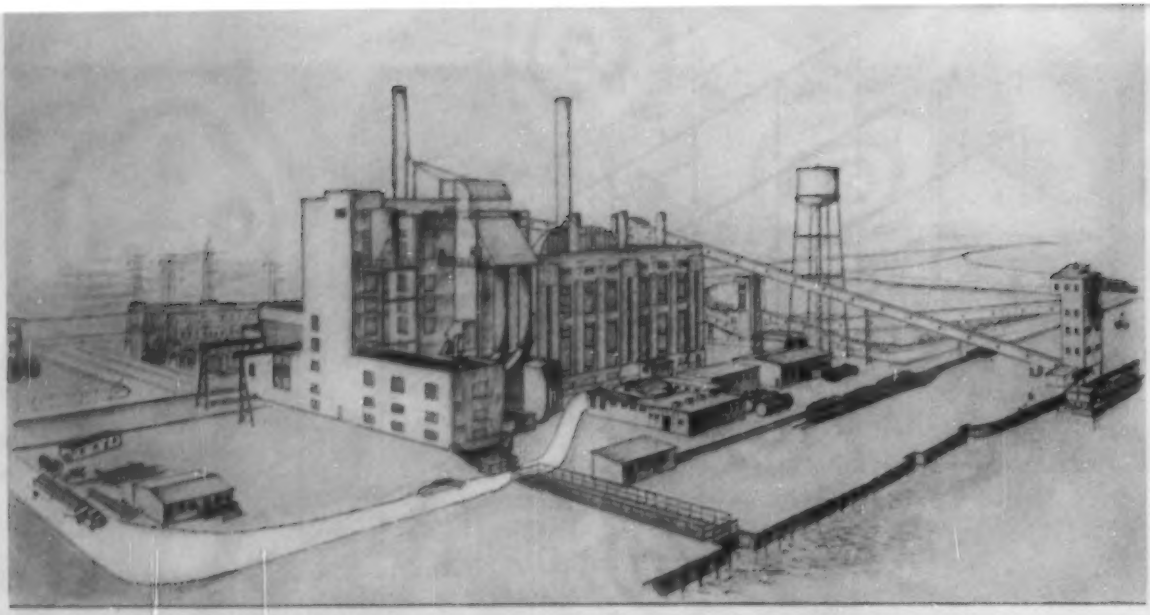
While the 100-psi compressor is limited to 11 stations and the 50-psi unit to 12, the blower can deliver 125 cfm when driven by a 1.5-hp motor. It will serve 23 stations having ¼-in. nozzles.

By reducing the low-pressure nozzle diameter to 0.153 in., almost the same axial velocity can be obtained 4 in. from the outlet while delivering 1.98 cfm, or 0.149 lb per min, as with 35-psi air in a 1/16-in. nozzle. In other words, we can obtain the same blowing effect with 1.5-psi air and a 0.153-in. nozzle as with 35-psi air and a 1/16-in. nozzle. A 1.5-hp drive on a blower will supply 63 stations using 0.153-in. nozzles.

Design procedure. To set up a low-pressure blowing system, determine the volume discharged by each nozzle, using the procedure given above. Multiply the flow from one nozzle by the number of nozzles in use at any given time. This gives total volume needed.

Required pressure at the blower discharge is found by calculating the losses in piping and hoses and adding to this the pressure at the nozzle. Pressure loss in a hose is usually taken as 2.5 times the loss in the pipe.

Centrifugal blowers are well-adapted to this service, combining steady pressures at varying air volumes with horsepower input directly proportional to the number of nozzles in use. They deliver clean air without many accessories.



RARITAN RIVER PLANT features many modern ideas in the equipment of its latest extension

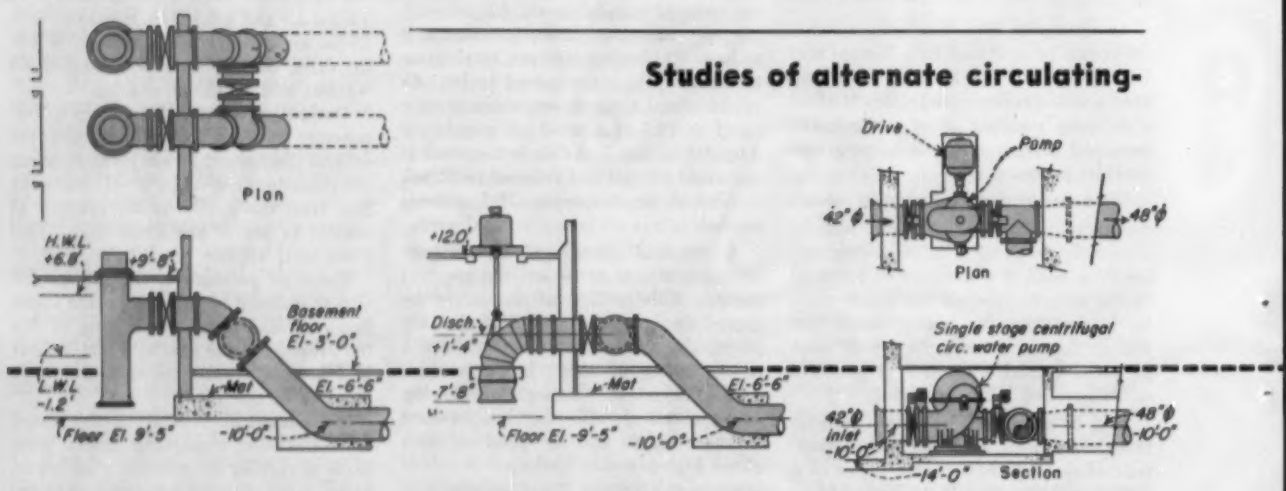
'Upside-down' pump solves design puzzle

The extension of Raritan River Plant of Jersey Central Power & Light Company posed the problem of choosing the best circulating-water pump arrangement. Bold thinking led to inverting vertical pump to save on investment and operation

By **A J GEGAN, Jr, and J T FONG,** *Burns and Roe Inc*

► OUTSTANDING FEATURES of generating stations develop from careful analysis of designs and plans. The latest extension of Raritan River Plant of the Jersey Central Power & Light Co, at Sayreville, N. J., has several noteworthy details: a condenser supporting a 125,000-kw turbine-generator, a compact coal-handling system, pressurized cyclone furnace, an unusually low turbine heat rate of 7614 Btu per kwhr. We will describe here how we chose an unusual installation of two circulating-water pumps for the condenser.

Studies of alternate circulating-

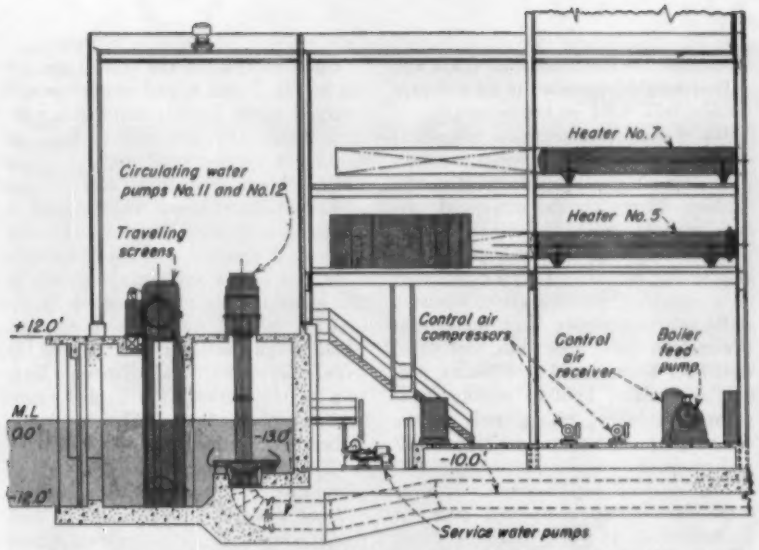


2 Using conventional pump setup makes discharge pipes cut through the floor

3 Propeller-type pump uses even more floor space than the pump in Fig. 2

4 Horizontal pump in dry pit involves more structural cost, uses more space

UPSIDE-DOWN PUMP continued



1 Fitting in the upside-down vertical pumps for circulating water in this manner opened up space for other equipment, giving a better over-all plant arrangement

Circulating-water system itself is a conventional arrangement. Normally the two pumps deliver 37,700 gpm each at 27-ft total dynamic head to a Westinghouse surface condenser supporting a General Electric 100/125-mw 3600-rpm turbine-generator. If one pump fails, the other can deliver two thirds of the combined design flow.

An interlock system delays pump starting by about 10 sec after the 48-in. control valves have passed through the 45-degree open position. This prevents the pumps discharging against a shut-off head that develops a 33,000-lb upthrust on the motor. The interlock prevents closing the motor-operated control valves before shutting down the circulating-water pumps.

The circulating-water system has an intake with bar screens at the bulkhead line. A steel-sheet-piled open intake channel leads the water to three traveling screens in the pump pit. From the pumps' discharges, two 48-in. steel pipes embedded in a concrete mat lead the water to the condenser inlets. Water from the condenser flows through a reinforced-concrete tunnel to a discharge well with provisions for a future unit. From here it discharges through a 96-in. concrete pipe into a discharge canal running to the river.

We would have used a conventional pump arrangement if we could. But the basement floor elevation of –3 ft, top-of-mat elevation of –6 ft 6 in., and –10 ft center line of the circulating-water pipe gave us some problems. Also, the record low-water level of –4.2 ft in the river required setting the pump suction several feet lower to obtain positive submergence. We had to find the most practical and economical way of discharging the circulating water into the 48-in. lines embedded in the building mat.

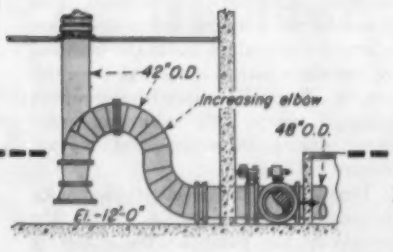
Comparisons. We first studied several layouts shown in Fig. 2 to 7. This included checks on the submergence needs of the different pump types.

Fig. 2 shows the layout for two conventional single-suction mixed-flow vertical pumps. The pump's discharge slopes down to the –10-ft elevation. The sketch shows the elevations primarily and not the true central locations of the pumps. The water travels through a loop with part of the pipe exposed above the basement floor. As far as the pit is concerned the layout appears desirable because the pumps need no separate housing.

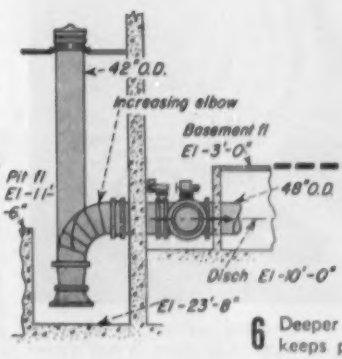
Cost figures justified this layout economically compared to the separate interior pit shown in Fig. 4. Routing of the discharge water, however, could be improved since the 48-in. valves and cross connection take up some valuable basement space, tentatively reserved for river-water service pumps. We also felt that the discharge-valve location added to the problem of servicing the pumps.

Fig. 3, similar to Fig. 2, has single-suction propeller-type vertical pumps with relatively higher specific speed. This self-priming pump also has a discharge loop. The pump needs less brake horsepower than a mixed-flow type when one unit alone carries two thirds of the combined design capacities of two pumps. This arrangement was not favored because the valves and cross

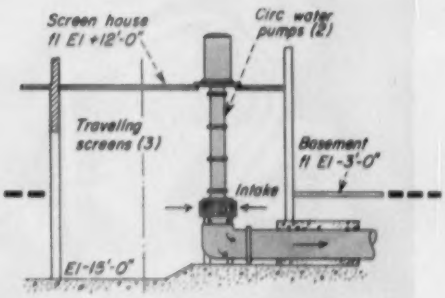
water layouts led to adopting this new pump design



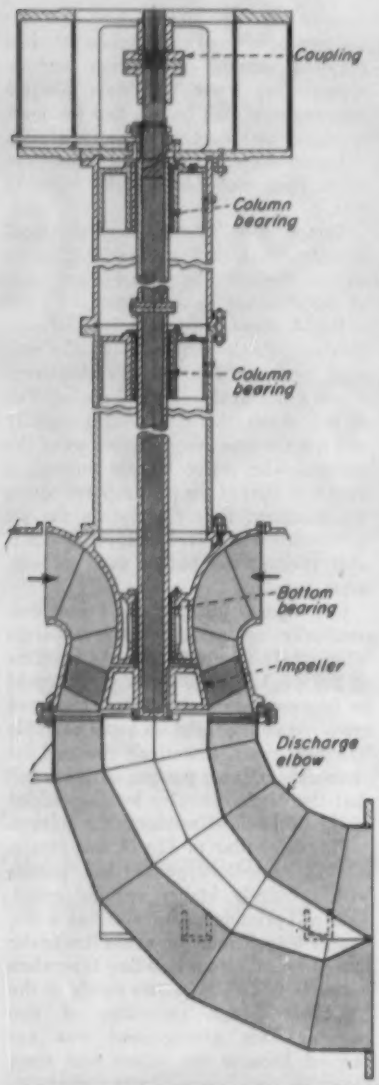
5 Discharge loop makes screen chamber wider, keeps pipe below floor level



6 Deeper screen chamber also keeps pipe under the floor



7 Inverted pump solves puzzle without changing screen pit



connection use basement floor space and a diver would be needed to do ordinary maintenance work on the pumps.

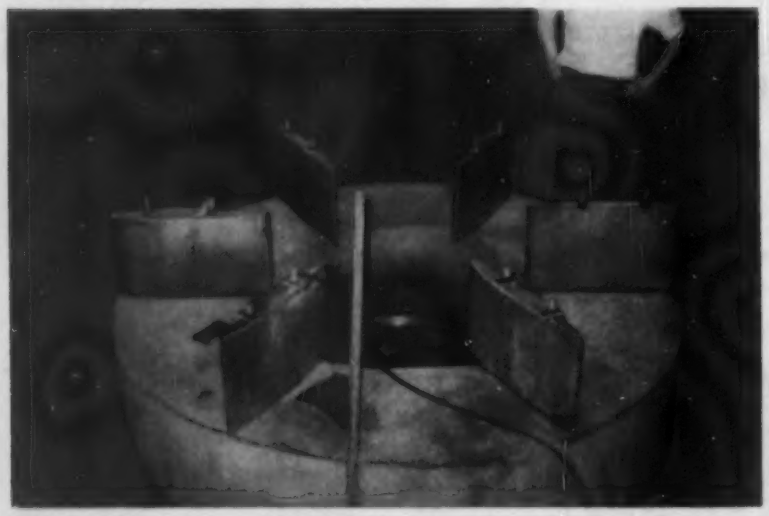
Fig. 4 uses a conventional horizontal single-stage centrifugal pump in a dry pit below the basement floor. Here the decision hinges on the structural savings realized from one of the better schemes. This layout achieves a 30% cost saving in reduced screen chamber area, considering: excavation, concrete walls, concrete coping, corrugated transite exterior walls, floor slabs, roof slabs, steel floor beams, steel roof beams, precast roof slabs, built-up roofing, temporary steel-sheet piling, well points, cleaning up, and contractor's overhead and profit.

The interior pit, however, involves extra excavation, reinforced concrete work, steel-sheet piling, slabs, grating, supports, etc, with costs 50% more than that of the reduced screen chamber. This scheme, compared to the previous two, costs 80% more in structural items. While the dry pit offers advantages in future pump-maintenance work, it's hard to justify economically because the pump usually costs more and has less desirable characteristics.

Fig. 6 shows an attempt to avoid the discharge loop by using a deeper wet pit and screen chamber. Fig. 5 shows a wider pit and chamber so the discharge loop does not pass through the basement floor. In both, higher costs decrease their attractiveness, and a diver would again be needed for pump maintenance.

←

8 Discharge elbow of inverted mixed-flow pump is set in a concrete mat



9 Inlet-vane assembly under construction shows six raided splitters in place to guide water into pump inlet with minimum turbulence. Top plate is not shown

Fig. 7 retains the low cost of the wet pit in Fig. 2 and 3, and routes the discharged water directly under the basement floor. This can only be done by turning a conventional vertical pump upside down. Structural cost savings and simplicity of layout become marked advantages. Since all parts stand under water or in concrete under the basement floor, the valves and fittings shown in the other layouts are relocated in accessible places near the condenser. Final design considerations changed the bypass between the two discharge lines to a location between the divided waterboxes of the condenser. Also, we finally embedded the discharge elbow in concrete so it could support the complete pump inlet-vane assembly, Fig. 1.

Final design. After evaluating bids from several manufacturers the contract was awarded to the Byron Jackson Company. Fig. 8 shows a section through the pump finally selected. Fig. 1 shows its placement in the plant.

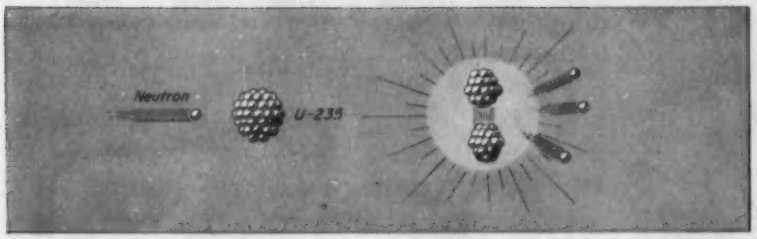
Each pump is driven by a Westinghouse 350-hp 390-rpm induction motor and supported by the motor base on top of the pump pit. A long stainless-316 shaft finished in two sections and supported within a cast-iron column of equal length drives the impeller. The latter takes water through a cast-iron suction head, analogous to a pump casing. The stainless-316 discharge elbow had to be positioned when concrete was poured under the pit. The bottom bearing and all column bearings are of rubber in stainless 18-8 shell.

To minimize turbulence at pump suction inlet we designed a circular suction plate, Fig. 9. The radial splitters act as guide vanes between top and bottom plates (top plate not shown). Minimum pump submergence is based on an extreme low-water elevation of –4.2 ft while the final center line of discharge has an elevation of –13 ft. Pump efficiency at design point equals 77%.

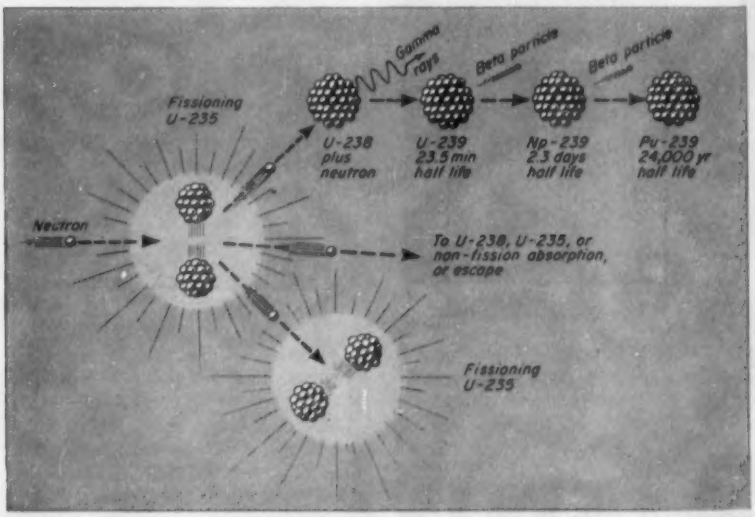
Installation. The pump builder designed the stainless discharge elbows. They had to be delivered ahead of the pumps to be set in the concrete, Fig. 1. Six pads attached to the outside of each elbow helped position them. Two dowels, each 4 ft long, in the base plate above the sole plate, guide the lowering of the whole assembly through the splitter eye. Normal monorail hoists above the two pumps help raise and lower them during inspection and maintenance work.

During installation one of the major precautions was to avoid placing the weight of the pump on the centering ring. This would compress and crush the rubber gasket. The sole plate at support surface above the pit carries

(*Continued on page* 216)



1 Key to nuclear-energy release from uranium-235 depends on its capturing a neutron. Excess energy makes nucleus fission and throw out more neutrons promptly



2 Neutrons thrown out by fission fragments may (1) convert fertile U-238 to fissionable Pu-239 (2) fission U-235 nuclei, or (3) be captured or escape to waste

Only 16 short years ago, in 1939, our scientists discovered how to split the uranium atom. Since then we have learned much about the reaction and how to control it. To do this we must know the many details of . . .

Nuclear fission and its results

By **HENRY C SCHWENK**, *Henry Pratt Company*
and **ROBERT H SHANNON**, *United Engineers and Constructors Inc*

► WE HAVE ALREADY MET our primary *fissionable material*, natural uranium. It consists of three isotopes: U-238 (99.3%), U-235 (0.7%) and U-234 (trace amounts). U-235 can be fissioned by either fast or slow (thermal) neutrons, but only fast neutrons (1 mev or more) can fission U-238. So it's easy to understand why U-235 forms the foundation of the entire nuclear-energy program.

We can fission other common elements of high atomic number, but only by using incident particles with very high energy. Since the fission reaction does not produce such high-energy particles it cannot be self-sustaining. Today, these reactions are only important in laboratory study.

A fertile material cannot sustain a chain reaction. But if it is exposed to

neutron bombardment and absorbs them, it converts to a fissionable material. Two fertile materials known today, U-238 and thorium-232, can be placed in a reactor running on, say, U-235, and be converted into fissionable isotopes. The reaction for U-238 is:

$$_{92}U^{238} + {}_0n^1 \rightarrow {}_{92}U^{239} + \gamma$$

A (n, γ) reaction where slow neutrons produced by U-235 fissions combine with the U-238 to produce U-239 with a release of gamma radiation. The U-239 has a half-life of 23.5 minutes, emitting negative beta particles and forming an isotope of element 93, neptunium:

$$_{92}U^{239} \xrightarrow{23.5\ \text{min}} {}_{-1}e^0 + {}_{93}Np^{239}$$

The neptunium-239 has a half life of 2.3 days and decays by radiating beta particles, that is,

$$_{93}Np^{239} \xrightarrow{2.3\ \text{days}} {}_{-1}e^0 + {}_{94}Pu^{239}$$

This process forms the isotope Pu-239 of element 94, plutonium, Fig. 2. The Pu-239 can be separated from the fertile material and used to fuel other reactors or in atomic weapons. Plutonium exists in nature in only trace amounts, and in a sense, is an isotope of an artificial element.

Fertile thorium-232 can be handled in the same manner to produce another fissionable material, uranium-233. In this case:

$$_{90}Th^{232} + {}_0n^1 \rightarrow {}_{90}Th^{233} + \gamma$$

$$_{90}Th^{233} \xrightarrow{23.5\ \text{min}} {}_{-1}e^0 + {}_{91}Pa^{233}$$

$$_{91}Pa^{233} \xrightarrow{27.4\ \text{days}} {}_{-1}e^0 + {}_{92}U^{233}$$

This series produces the intermediate element 91, protactinium.

Although fissionable U-233 and Pu-239 derive from abundant Th-232 and U-238, the conversion processes need neutrons coming from fissioning U-235. In other words, we must consume fissionable material to produce fissionable material. Later in this study course we will study the "breeder reactor" which can produce more fissionable material than it consumes while also releasing usable heat energy.

U-233 and Pu-239 fission with both thermal and fast neutrons, just like U-235. This makes them of great importance in the nuclear reactor program.

Thermal vs fast neutron fission. Why does a thermal neutron fission U-235 and not U-238? How can thermal neutrons with only a fraction of an electron volt fission U-235, while millions of electron volts are needed for U-238? It's all a matter of relative stability.

Materials fissioned by thermal neutrons (U-233, U-235, Pu-239) all have nuclei with an even number of protons and an odd number of neutrons. But U-238 and Th-232 have even numbers of both neutrons and protons. Let's list these isotopes:

Isotope	*Protons*	*Neutrons*	*Mass No.*
U-233	92	141	233
U-235	92	143	235
Pu-239	94	145	239
U-238	92	142	238
Th-232	90	142	232

The capture of a neutron by the first three isotopes transforms an even-odd nucleus to an even-even nucleus, for example:

$_{92}U^{235} + {}_0n^1 \rightarrow {}_{92}U^{236} \rightarrow$ fission

while with U-238 the transformation goes from even-even to even-odd:

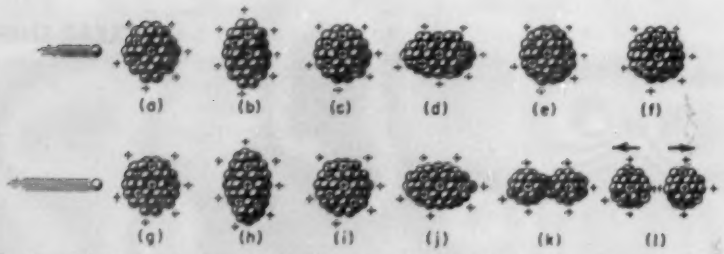
$$_{92}U^{238} + {}_0n^1 \rightarrow {}_{92}U^{239} + \gamma$$

The even-even nuclei are more stable, thus a greater amount of energy is available from the first reaction with an even-odd nucleus. The compound nucleus formed by U-235 and a neutron is in a more energetic state than that formed by U-238 and a neutron. Hence U-235 fissions very easily when absorbing a thermal neutron. With even-even nuclei like U-238 and Th-232 the excitation energy from capturing a neutron is relatively smaller, and hence the neutron must have high energy to cause fission.

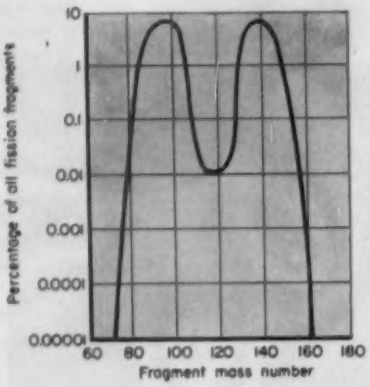
Fissioning is most often explained by the "liquid-drop model" of the atomic nucleus. Physicists believe the binding energies of nuclei are about proportional to the number of nucleons in them and that a nucleus might behave like a drop of water. Mutual attraction between molecules in a water drop make them form into a sphere that resists deformation. Nucleons probably behave in a similar fashion within a nucleus. The water droplet or nucleus can be distorted or split in two only by supplying additional external energy.

Fig. 3*a* to *f* shows what might happen to a water drop hit by a small particle. If there is not enough energy to split the drop, it will vibrate, changing its shape between spherical and egg-shaped, finally coming to rest in its original spherical form. The mutual internal molecular forces were strong enough to resist the impact of added energy.

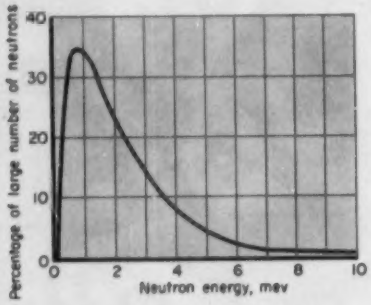
In Fig. 3*g* to *l* a higher energy particle hits the drop again, causing it to vibrate, but this time the drop elongates at *k* so the reduced internal forces at



3 Liquid-drop model, theory, *a* to *f*, assumes low-energy neutron may only vibrate nucleus or, *g* to *l*, higher energy neutron may cause protons to help split atom

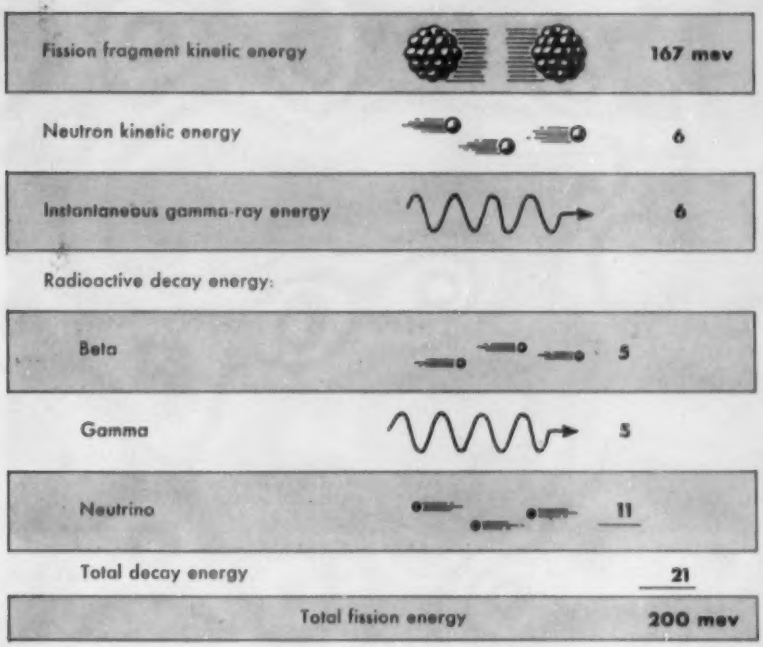


4 Most U-235 nuclei split into unequal sized fragments, few are nearly equal



5 Neutron energies vary over large range; most are around 1 mev level

Energy division of fissioning uranium



6 Energy from U-235 fission goes mostly to speeding up fission fragments. This quickly appears as heat. Minor portions of energy largely convert to heat, too

the constriction can't pull the two bulges back together again. Once this stage has been reached the water drop is more stable as two separate droplets, and it splits in two.

This analogy applies easily to nuclear fission. A neutron combines with a uranium nucleus to form a highly excited compound nucleus. The excess energy comes from the binding energy of the neutron plus its kinetic energy. This excess energy causes the compound nucleus to vibrate as in Fig. 3. For lower levels of excess energy the nucleus ends up in spherical form, but the excess energy leaves as radiation or an expelled particle.

For higher levels of excess energy entering with the neutron the nucleus might vibrate to the point where it forms two bulges—a dumbbell. Now in addition to reduction of the cohesive forces between nucleons at the constriction, we have the grouped positive charges of the protons in the two bulges repelling each other. These simultaneous conditions split the nucleus and both the binding energy change and the electrical repulsion send the two fragments flying away from each other.

Summarizing the fission process we have: (1) energy released as heat, the useful product (2) neutrons ejected to maintain and propagate the chain reaction (3) fission products or fragments of the split nuclei, which must be removed as a waste. Let's study each of these conditions.

Energy released by each fissioned atom of U-235 amounts to about 200 mev. This compares with the few mev per atom that most chemical reactions release. In Part 4 (Oct 1954 POWER, pp 107-109) we studied the conversion of mass to energy. Let's apply this to the fissioning of a U-235 atom and see what happens. Before fission we have the following atomic mass units (amu):

Particle	*Mass, amu*
U-235 atom	235.124
Incident neutron	1.00897
Total	236.13297

After splitting, the fission fragments often have mass numbers of the order of 95 (Mo-95) and 139 (La-139). In addition, there might be two neutrons ejected. After fission we then have:

Particle	*Mass, amu*
Mo-95	94.945
La-139	138.955
Two neutrons	2.01794
Total	235.91794

Subtracting the "before" and "after" atomic mass units, we see some mass disappears:

Before fission	236.13297
After fission	235.91794
Mass defect	0.215 amu

We learned that one amu equals 931 mev of energy, so fissioning of one U-235 atom releases $931 \times 0.215 = 200$ mev. Actually a U-235 atom can split several different ways, the one we just looked at being typical.

The energy released by fissioning divides as shown in Fig. 6. Kinetic energy of the fission fragments appears immediately as heat, being the biggest and most important portion. Gamma rays and ejected neutrons carry off equal amounts. Remainder of the energy dissipates gradually as radioactive decay in the three forms shown.

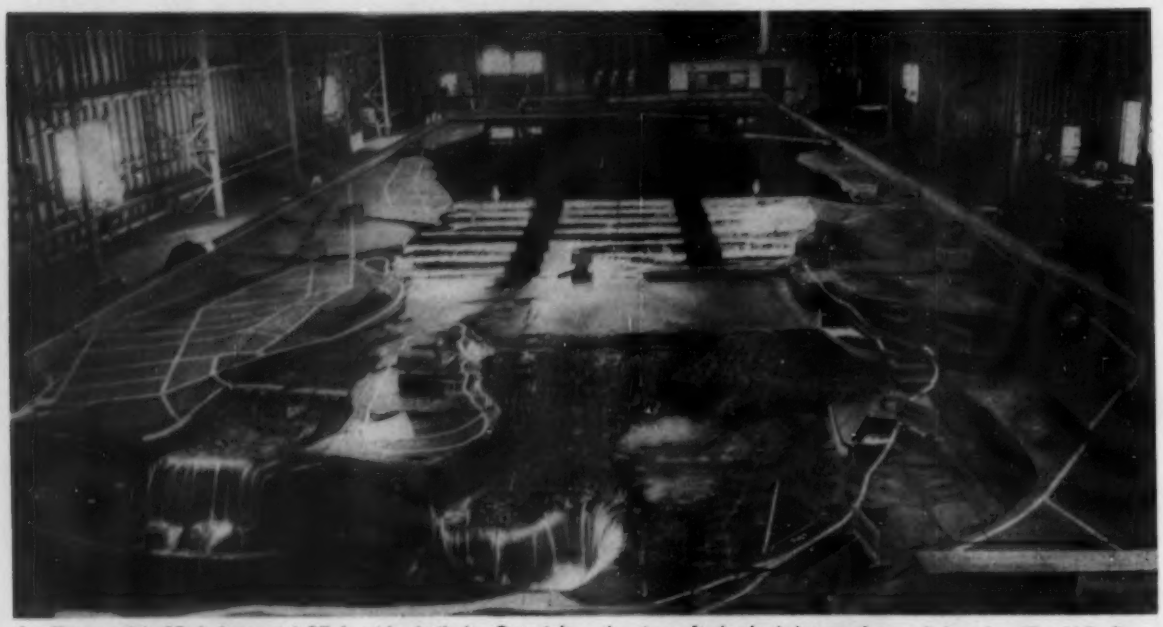
Initially only 179 mev of energy are produced, but this rises gradually to 200 mev as the fission products decay radioactively. The radioactive decay of fission products restricts severely the accessibility to reactors. Part of the radioactive energy contributes to producing heat in the reactor.

Prompt and delayed neutrons. The fission fragments are unstable immediately after fission, so they eject neutrons. Note that the neutrons are *not* ejected by the compound nucleus, but by the fragments after fission. The ejected neutrons are of two types: (1) prompt and (2) delayed. At least 99% are prompt, being ejected from the fission fragments within about 10^{-12} sec (0.000000000001 sec) after fission. The remainder leave the fragments at a decreasing rate over a period of minutes after fission. These delayed neutrons are important to reactor control—we will talk about this later in the course.

The average number of neutrons released per fission varies from 2.5 for U-235 to 3.0 for Pu-239. These values are *averages*, in some cases no neutrons are emitted, in others there may be one, two, three, four, etc. Fig. 5 shows how the energy of these neutrons is distributed. It is called the *fission spectrum*. Energy of the prompt fission neutrons covers a considerable range because of the many ways a uranium atom can split. Fig. 5 shows the most probable energy is slightly less than 1 mev.

Fission products. Compound nuclei usually break up into unsymmetrical pieces, that is, the fragments are not

(*Continued on page* 190)



1 This model, 95 ft long and 37 ft wide, built by Ontario's Hydro Commission, duplicates the Falls and five miles of the river. It checked design of remedial works. The U.S. Corps of Engineers also built model of Falls and river to Lake Erie

Niagara Falls to get a new look

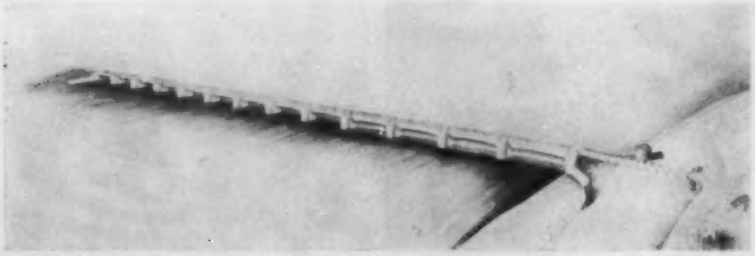
A $17½-million face-lifting operation is now being performed on the Falls. The work, which is well under way, will enhance its scenic beauty, permit increased water diversion for power generation, stop erosion. Canada and U.S. share cost equally

► FOR MANY YEARS Canadian and U.S. engineers have studied preventing erosion at Niagara Falls by remedial works constructed in the Niagara River. But it was not until a new treaty was ratified in 1950 to permit greater diversion of water for power generation that such works became a pressing need. Under this treaty the International Joint Commission was given a trusteeship to preserve and enhance the beauty of the Falls and the river.

Remedial works. On July 22, 1953, the International Niagara Board of Control authorized construction of remedial works on the Canadian side of the Niagara River. These were developed by engineers of the Canadian government, Hydro-Electric Power Commission of Ontario and the U.S. Corps of Engineers, working in close cooperation, after exhaustive studies of the river. The plans were ratified in principle, on Nov 20, 1952 by the International Joint Commission and the Niagara Park Commission.

Canada and the U.S. are constructing these works to: (1) distribute water flow over Horseshoe Falls, as required by the treaty, to obtain an unbroken curtain from shore to shore at all times (2) stop erosion at the center of Horseshoe Falls (3) retain present conditions in Chippewa-Grass Island Pool and up river and over the American Falls so the most effective use of water for power can be made without in any way impairing the scenic beauty of the Falls.

Work is being done, as in Fig. 3, by building a structure at the lower end of the Chippewa-Grass Island Pool to control its level. It is from this pool that practically all water for power generation will be taken when over-all developments are completed on the Canadian and U.S. sides of the river. Located on the Canadian side of the river, the remedial structure, 1550 ft long, will be about 1½ miles above the Falls. It will be a submerged reinforced-concrete weir with an adjustable crest, controlled by



2 Artist's drawing of remedial works in which 13 bascule-type gates will control the water level in Chippewa-Grass Island Pool, 1.5 miles above Niagara Falls

3 This map of the river shows where remedial works are being built above the Falls, areas to be excavated, fills to be made near the brink of the cataract

13 gates, 100 ft long, supported between 14 reinforced-concrete piers.

These bascule-type gates are hinged at their bottom edge and will always be submerged. Pool level will be controlled by raising or lowering the free edges of the gates, much as one half of a bascule bridge is opened and closed. Electrically controlled hydraulic cylinders, in the piers, will position the gates from stations at the piers and on shore.

So as not to interfere with water flow over the Falls, only two gates will be installed at a time. When the structure is completed in about three years it will have the appearance of a graceful bridge, Fig. 2, which will not in any way detract from the beauty of the river.

Excavations and fills. Fig. 3, shows the center of Horseshoe Falls has eroded far back of the flanks on the Canadian shore and on Goat Island. As a result, most of the flow is concentrated in the center of Horseshoe and very little or none over its flanks. To correct this, about 25,000 cu yd of rock will be excavated from the Goat Island flank and 64,000 cu yd from the Canadian.

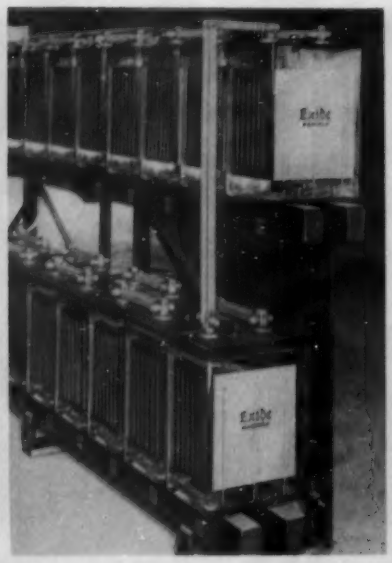
Incidental flow at the ends of the crest will be eliminated by filling in with rock and earth as shown. These fills will be made so they will blend with the landscape of which they are a part.

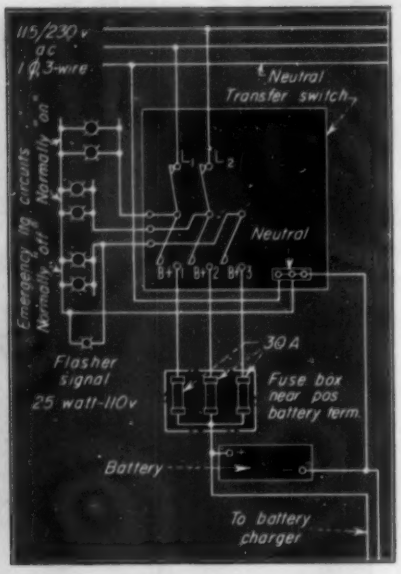
Models of the Falls. To divert water from the Niagara River for increased power generation and to distribute the remaining water over the Falls in an unbroken curtain involved many complicated hydraulic flow problems. To insure their best solution it was the opinion of the International Niagara Falls Engineering Board that the use of hydraulic scale models was the only reliable way of obtaining the extensive and complex information needed. In the interest of accuracy and maximum benefits from the studies, the Board recommended using two models, one in Canada and one in the U.S.

Hydro-Electric Power Commission of Ontario built one of these at its Islington service station near Toronto. This model, 95 ft long by 37 ft wide, duplicates the Falls and the river to Grand Island and includes the intakes to all power plants on the Canadian and U.S. sides of the river. The U.S. Corps of Engineers also built a model 260 ft long by 125 ft wide in its Vicksburg, Miss. hydraulic laboratory. This practically duplicates the model built by Hydro, but includes the river to Lake Erie. Before the models were constructed, accurate information was obtained by sounding and other methods on every detail of the river. In these models, river flow is simulated under any conditions and miniature remedial works inserted at any desired location. It was, therefore, possible to study their performance under a wide range of river flow.

Two models offered many advantages: They insured accuracy and made possible a constant check on test results as the studies progressed. These tests insured that the remedial works will, when completed do everything required to preserve the beauty of the Falls, and, at the same time, permit full use of water allowed by the treaty for power generation.

Who does the work? All construction and excavation for the remedial works on the Canadian side of the Falls is being done by the Hydro-Electric Power Commission of Ontario and on the American side by the U.S. Corps of Engineers. Ontario Hydro is now working on the structures for the first two gates and the Corps of Engineers has contracted for excavation on the Goat Island flank of the Falls, which is now being made. A contract for the 13 bascule-type steel gates, which form part of the remedial works structure, has been let to Canadian Vickers, Ltd. Work is now well under way so that the $17,500,000 job will be completed well within the four years required by the 1950 Treaty. The project cost is being shared equally by the U.S. and Canada.





READY... for an outage with storage batteries developing 6, 32 or 115 volts . . .

Batteries: a 3-way bet for emergency lighting

You can choose an engine-generator (*Power*, Sept 1954, pp 120-121), an emergency feeder from another section of the utility, or any one of these three storage battery systems

By L E LIGHTON, *Vice-President*
The Electric Storage Battery Co

►WHEN LIGHTS FAIL in a busy plant, anything can happen—accidents, panic, pilferage, equipment damage. Even with the increasing adoption of automatic equipment, adequate emergency lighting is still needed: Personal safety and emergency control of production equipment must be provided for.

State regulations and local laws often specify just where to install such lighting. Pennsylvania, for example, lists some 115 locations where this equipment is used. Its Code states that plants employing more than 25 workers must have emergency lighting.

National Electrical Code recommends certain practices (see Article 700 in 1953 NEC). Look into insurance requirements when analyzing emergency lighting needs.

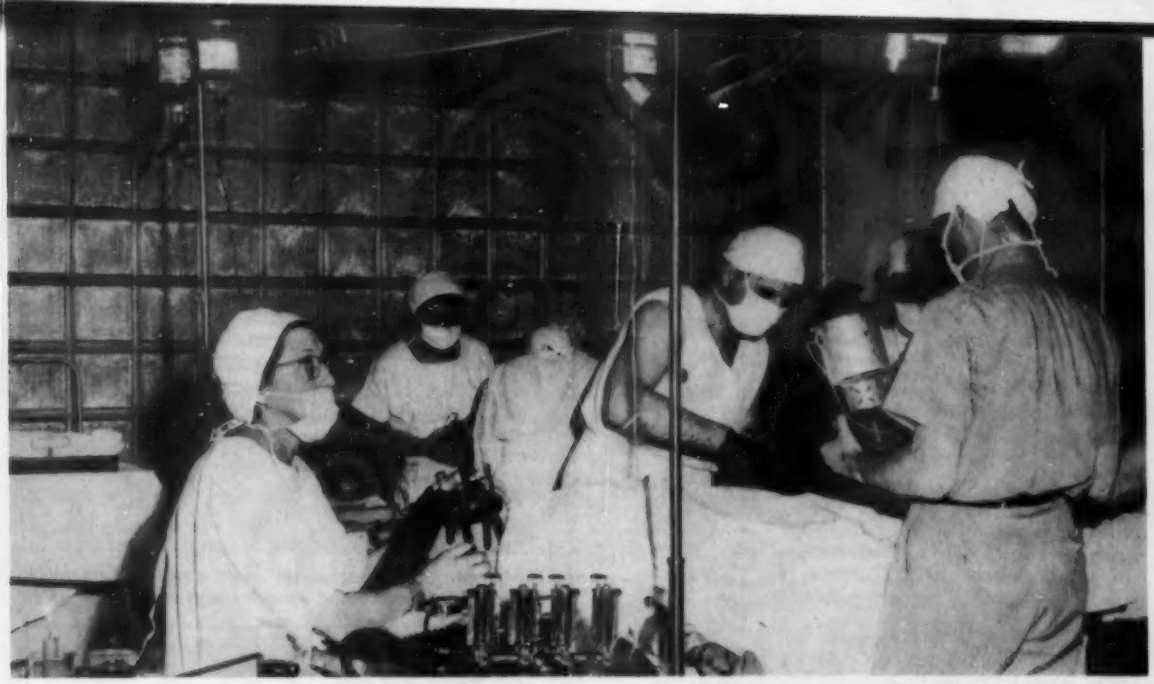
Consider the following when thinking out your installation:

1. Will plant workers be plunged into total darkness if feed to lighting fails?
2. Can production machines be damaged if the lights go out? Is emergency communication provided for?
3. What about stealing? Is there a security problem? Will there be open safes or confidential information, drawings on desks and worktables?
4. Do you have an in-plant dispensary? Here the need for emergency lighting is obvious.

What basic supply to select generally boils down to choosing between batteries and an engine-generator. After that determine specifically what electrical load must be handled under emergency conditions. This can be measured directly, preferably with a recording ammeter or wattmeter, during season of maximum load. *Discount all load that can operate only on ac.*

Study probability of a complete electrical power failure. A complete failure is mentioned since tie-breakers between incoming or in-plant feeders handle some portion of the load should a partial failure occur.

Thinking differs, however, on the importance of multiple-feeders to the plant. Lily-Tulip Cup Corp's College Point plant in Flushing, N.Y. employs more than 2100 of whom about 800 are women. According to John Dorer, chief electrical engineer, the plant is powered by a single 4160-v feeder from a Consolidated Edison substation and five



or NOT... as was the case in this Cleveland hospital when all power failed

feeds from the utility's 208-v network.

In a discussion between Dorer and William H McLaughlin, director of safety and sanitation at Lily-Tulip, additional emergency protection was agreed on for worker safety. Here, self-contained 6-v storage battery units were chosen for some 20 locations. Two-lamp units were selected, consisting of spotlight and floodlight sealed-beam lamps. Minimum of 3½ hours of continuous operation may be expected from each unit. Dorer adds that no power failure in more than 10 years has lasted beyond this time limit for battery units.

Voltage for emergency-lighting equipment can be narrowed down to 6, 32 and 115 volts. Following are the factors to consider in pinning down a specific voltage for your plant:

115-v installations are most attractive for new construction. Such a system handles some part of the lighting load from a set of standby batteries in a central location. Since the emergency-power source floats off the main power source, parallel circuit wiring is unnecessary, trimming installation cost. With a central location for storage battery, figure voltage drop to most remote lamps in system.

With this setup, load is shifted to the emergency-power source if supply voltage fails or drops to about 70% normal. Emergency power is maintained until incoming voltage builds to about 90% normal. The NEC (Article 700, Section 7012) recommends storage batteries be capable of carrying emergency load for at least one-half hour while maintaining at least 91% of the initial battery voltage.

Determining battery size is simply a matter of pinpointing the full emergency load in amperes and selecting batteries of sufficient capacity to support the load for required time—1, 2, 4 or 8 hours.

Through judicious allocation of power, a system rated for, say, one hour may last many times longer by cutting off all but high-priority lights. But regardless of length of emergency service, the National Electrical Code permits line voltage to drop no lower than 105 on 115-v circuits. In some areas local regulations permit a drop to 100 v as a final voltage. After the minimum voltage is passed, connected lamps will continue to burn but at a faster decreasing rate of light output.

32-v systems are powered from 18-cell batteries. Where emergency lighting is concentrated in two or more locations, say in opposite wings of a building, a 115-v system may prove too costly. Distance between load centers introduces too great a voltage drop for one central battery and too high a cost for separate 115-v units. In such cases, a 32-v system for each load may be the wiser choice.

6-v units appeal to many power-service engineers in industrial plants. But in a large new building, cost of a 6-v system is considerably higher than that of a 115-v setup. Former may, however, easily be installed in existing structures. Six-volt units may be used advantageously also where required emergency lighting is scattered and 115- and 32-v installations need extensive new feeder and branch-circuit wiring.

With the 6-v storage battery setup, each unit is actuated by a power outage to light a completely independent lamp or lamps from a self-contained battery. The battery is maintained fully charged by a trickle charger built in the unit. When normal power is restored, unit automatically turns off its lamps and turns on its trickle charger which operates to recharge the battery. Specifications generally call for a complete recharge within 12 hours.

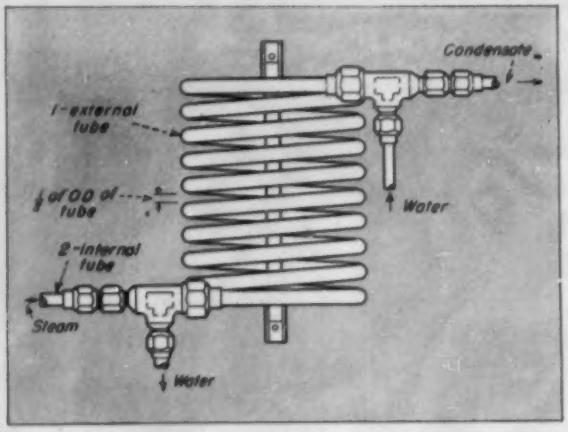
Dry-cell battery-powered 6-v units are also available for emergency lighting. Since these batteries are not rechargeable, regular checking is necessary to assure that batteries are always in operating condition.

Maintenance of storage-battery systems generally consists of periodically checking battery's charge plus addition of water. Some batteries now incorporate a means for reading state of charge from a distance of several feet — a significant help when the unit is in an inconvenient spot. In one such arrangement, colored balls in one corner of the unit rise and fall with the state of charge. Claims are that such indicators are visible for more than 20 ft.

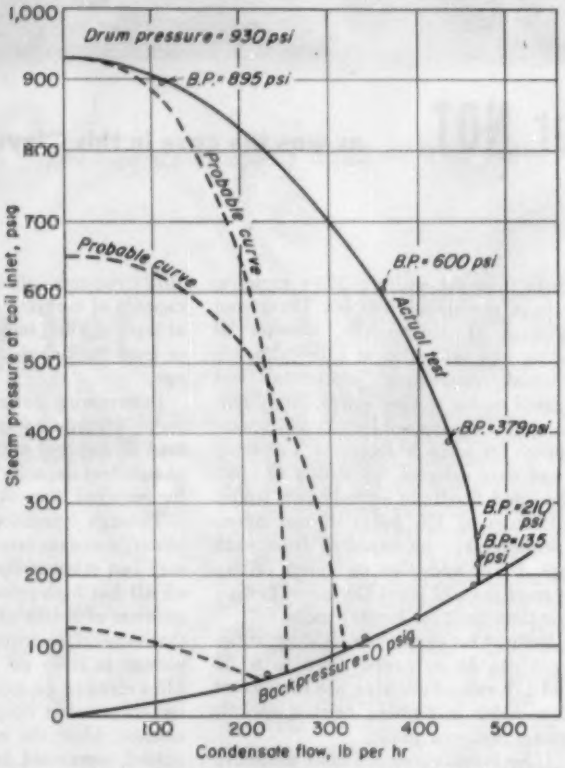
How to size coils to condense your steam samples

Now, heat-transfer coils for condensing steam samples can be chosen quickly once you know size of sample wanted, steam pressure, and cooling-water pressure and temperature

By **R B RESEK**, *Chief Development Engineer*
and **W G WEBSTER**, *Test Engineer*
The Parker Appliance Company



1 Dual heat-transfer coil passes steam sample flow through internal tube, and cooling water through the annular space

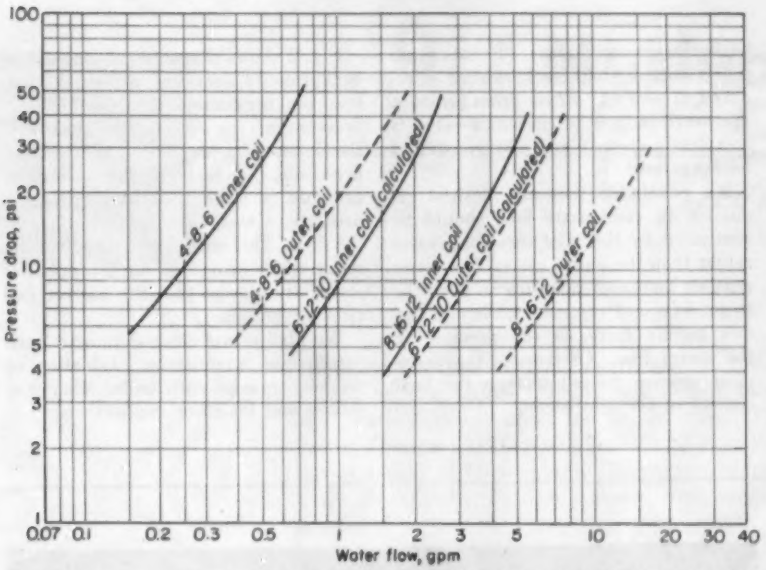


2 Condensate flow through 8-16-12 copper-steel coil depends on both initial drum pressure and backpressure in the coil

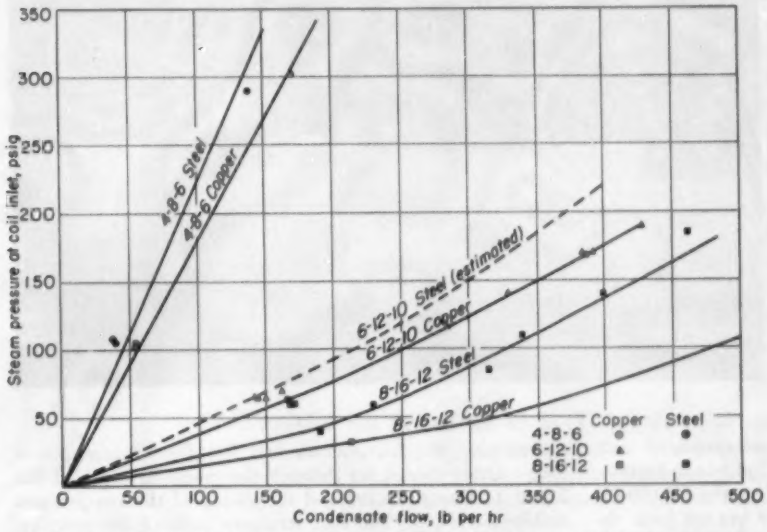
► IN SEARCHING for the most efficient fluid-heat-transfer apparatus our firm developed the "dual heat-transfer coil." The unit, Fig. 1, consists of two coils of tubing, one tube inside the other. One fluid flows through the inner tube, and the other in the annular space between inner and outer tubes. This arrangement has been used for all applications of heat transfer between fluids. The dual heat-transfer coil, however, primarily serves as a condenser for steam samples in generating plants.

Lack of adequate data from the field complicated the selection of the proper-sized coil for a given application. The only reference material available was based on tests with steam condensed at constant pressure and a controlled rate. A sampling coil rarely works under these conditions. So we set out to compile performance data on these coils to help make quick and positive selection. We did this by running tests under actual power-plant sampling conditions.

Testing methods. The heat-transfer coils are made of either copper or stainless steel. The stock coils use 19½ ft of outer tubing and 20 ft of inner tubing. Sizes are specified by a series of



3 Pressure drop of water flow through the dual heat-transfer coil passages rises rapidly with increasing water flow. These tests used water at room temperature



4 Condensate flow through dual heat-transfer coil passages varies almost proportionally with the steam pressure at the coil inlet. Backpressure is atmospheric

three numbers. These give respectively the number of sixteenth inches in: outside diameter of internal tube, outside diameter of external tube, and outside diameter of tube fitting for cooling water. Available coils are: 4-8-6; 6-12-10; 8-16-12.

We conducted tests on condensing saturated steam at the Avon Plant of Cleveland Electric Illuminating Co and at our own boiler house. We measured pressure drop through inner tubes and the annular spaces at various flow rates.

For the steam tests we attached the coils to saturated steam and cooling-water sources so the flows were countercurrent. We read temperatures at inlets and outlets of both steam and water coils with a thermocouple and potentiometer. Pressures were read by gage at inlet and outlet of the steam coil. We weighed the condensate and coolant flows.

Test results. Fig. 3 shows the pressure drop through inner and outer coils for various flow rates. Fig. 4 gives the steam pressure needed at the coil inlet for various flow rates of condensate when the coil-outlet pressure is atmospheric (0 psig).

Fig. 2 shows the results of throttling the steam-coil outlet to raise backpressure in the coil. This graph includes some calculated curves for other than test conditions.

Choosing size. With the information in the three graphs we can now intelligently select the proper coil for a given application. First we must know the following factors:

1. Amount of steam sample in pounds per hr.

2. Pressure of saturated steam *at the point of sampling* and at the flow rate required. This does not mean gage pressure of the drum or of the line when capped. The reading at the sampling-station tap takes into account the pressure drop of the steam as it flows through the line from the drum.

3. Cooling-water inlet temperature.

4. Cooling-water pressure and flow characteristics.

With these data in hand we are ready to make the following calculations:

1. Find the amount of heat that must be removed from the steam in Btu per hr. If the steam enthalpy is unknown, we can safely assume 1200 Btu per lb to be removed. Multiply the flow in lb per hr by this figure to get Btu per hr.

2. Assume an outlet temperature for the cooling water. We find 150 F is usually satisfactory.

3. To figure the amount of cooling water needed to remove the heat, divide the Btu per hr by the cooling-water temperature rise:

$$\text{Cooling water flow, lb per hr} = \frac{\text{Btu per hr}}{T_{out} - T_{in}}$$

4. If enough cooling-water flow data are available, choose the coil from Fig. 3 that has the required coolant capacity. If no data are provided, assume up to 1000 lb per hr for the 4-8-6 coil, 3500 lb per hr for the 6-12-10 coil, and 5000 lb per hr for the 8-16-12 coil. Most city-water systems can meet these specifications.

5. Refer to Fig. 4 to determine whether the coil chosen can safely handle condensate flow at the given pressure. If not, choose the next largest coil that passes enough condensate.

Adjustment. The prime factors to

know in selecting a coil that supplies a given amount of sample are: available steam pressure at coil inlet and pressure needed to circulate the required amount of cooling water. We found, however, that when there isn't enough coolant available to condense and cool the steam sample, a slight reduction in sample flow corrects the condition. Tests showed that changes in coolant flow tend to affect the temperature change of the coolant more than the condensate.

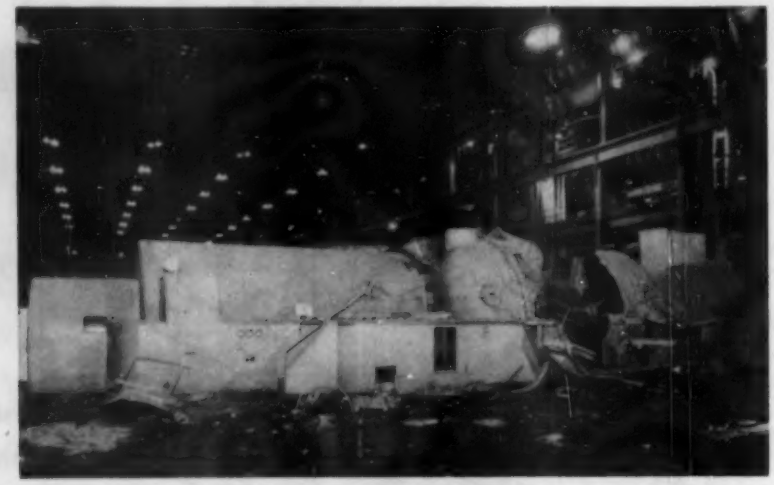
During the project we made several other observations. For example, three factors affect condensate flow under backpressure conditions: (1) maximum flow attained when backpressure is reduced to zero (2) steam drum pressure (pressure in coil when outlet valve is completely closed) and (3) amount of backpressure.

We concluded that any desired reduction in condensate flow should be controlled by the inlet throttling valve rather than the outlet valve. The latter puts an increased pressure on both the steam line and the coil, while the former merely increases the pressure in the steam line. Of course, the throttling process doesn't change the heat content of the inlet steam.

Fig. 2 shows that a small increase in backpressure does not appreciably affect the condensate flow if the inlet pressure of the coil is less than half the steam-drum pressure. For low drum pressures, however, if the coil inlet pressure is more than half the drum pressure, a small backpressure reduces the flow. This should be taken into account when providing for low-pressure steam systems so that the correct coil sizes are chosen.

We plan to use these data as a basis for further quantitative evaluation of the heat-transfer coils under other conditions and for other applications.

Low-pressure 1800-rpm turbine fails at Ridgeland



► THE LOW-PRESSURE TURBINE of a cross-compound unit exploded at Commonwealth Edison Co's Ridgeland Station, near Chicago. The spindle shaft had failed on the 160,000-kw unit No. 4, but the explosion's basic cause has not been determined. The accident, on Sunday, December 19, 1954 at 11:19 pm, shut down the station.

Flying pieces of metal killed two men, injured four more, and damaged the other 160,000-kw units in the plant, No. 1, 2 and 3. These three units were back in service within 50 hours.

Unit 4, built by Allis-Chalmers Manufacturing Co, had been in commercial operation since August 1954. It passed every normal test and gave no evidence of trouble.

The unit had been out of service for cleaning of the single 1800-psi 1050-F boiler. At the time of the accident the unit was being brought up to speed. The low-pressure element had been given its regular overspeed run and tripped within the 10% limit. The high-pressure element was being brought up for its overspeed check when the low-pressure turbine failed.

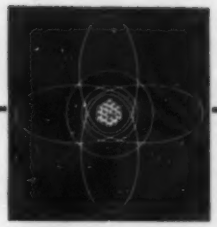
The center section of the spindle shaft broke into a number of pieces that carried much of the turbine casing with them. One section weighing several tons went through the building roof and landed in a coal pile. Another of comparable size ripped open the tail pipe on unit No. 1 condenser, 300 ft away. Other pieces cut through the crossover pipes of No. 2 and 3. One piece cracked the casing of the low-pressure turbine of No. 3. The roof structure suffered the most extensive building damage.

Units 1 and 3 tripped automatically while the control-room operator tripped No. 2. The operators remained at their posts and shut down the boilers in orderly fashion.

Repairs to the first three units included a new tail pipe for No. 1. It was 12 ft long and 5 ft in diameter made of ½-in. steel and welded into place. New sections were welded into the crossover pipes of No. 2 and 3. The casing crack of 3 was sealed by the metal-lock method and had a steel plate riveted on for added strength. The hydrogen-control panel of 3 had been wrecked and was replaced by one from the Will County Station, now under construction.

Replacing roof trusses, precast concrete roof slabs and other work in the station is still being done.

Investigation is under way to determine the basic cause of the spindle-shaft failure. The spindle design is not unusual. The forging had been subjected to all well-established factory tests, including ultrasonic and tests associated with interior boring. Manufacturer's warranty and insurance will probably cover a large part of the damage.



Nuclear notes

By B G A SKROTZKI, *Associate Editor*

Army package-reactor contract award goes to the American Locomotive Company. For a lump sum of $2,096,753 they will design, build and test-operate a prototype "package" nuclear power plant for military use. The 2000-kw prototype Army Package Power Reactor (APPR) will be built at Fort Belvoir, Va. Alco won with its low bid out of a field of 18 proposals. These ranged up to $6,900,000, and 12 of them were under $4,000,000. Bidders included wide range of manufacturers and consulting engineers.

Logistic savings offered by atomic power plants raises strong interest in the Army. Eliminating fuel, usually oil, reduces need for transport equipment and personnel. Fuel for some remote bases makes up more than half of total supply tonnage.

Liquid-metal alloy will be used first time in liquid-metal fuel reactor (LMFR) being developed by Brookhaven National Laboratory. The U-233 bismuth fuel stream flows between reactor, heat exchangers and continuous chemical processing. Latter (1) removes gases like xenon and iodine, liquid salts like potassium and lithium chloride (2) could draw off fission products while leaving uranium in the bismuth.

H-bomb tests in Pacific last spring had three unlooked-for aftereffects: (1) Nearly 300 people got large radiation doses. (2) Radioactive fish turned up in Japan. (3) Radioactive rain fell in many places. People affected included 23 Japanese fishermen on a boat 72 miles from blast on March 1st. They weren't hospitalized until March 28; one died. Fall-out affected 236 Marshall Islanders on three atolls, but all seemed to recover. Also exposed were 31 Americans, now OK. Of 905 boatloads of fish received in Japan, 77 were condemned.

Consolidated Edison Co of N. Y. bought a 340-acre tract on the Hudson River near Peekskill, N. Y., for a possible future atomic power plant. They engaged Vitro Corporation of America as consulting engineers in atomic energy. Exploratory discussions with manufacturers of atomic equipment have been under way for a time.

Aluminum-26 isotope was recently discovered by chemists at Carnegie Institute of Technology. This new cyclotron-produced radioisotope has a half life of about one million years. Previously known longest-lived radioactive aluminum isotope, Al-29, has a half life of less than 7 minutes.

Fund for Peaceful Atomic Development, Inc, has been organized by a group of leading scientists, educators and industrialists in the U.S. It will be first nongovernment operation to carry out Atoms-for-peace program of President Eisenhower. Initially the Fund will arrange for task forces from foreign countries to visit U.S. They will survey our atomic programs in all their phases: industrial, medical, educational, legal and agricultural.

Radium is most dangerous isotope of all the 800 radioactive species now known, says Dr W F Libby, AEC Commissioner. Long experience with radium has led us to expect that radioactivity will be more lethal than it really is. Actually a curie of one isotope may be more or less dangerous than a curie of another. One curie of radioactivity equals the disintegration of 2.2 million million atoms per min.

A 1954 award winner

HUDSON'S MODERNIZED POWER PLANT, pictured here, shows coal-handling equipment, deaerator house on roof, hot-lime-softener house and tile ash-storage silo

In deciding to modernize their power services, Hudson Motors made a wise move. Now they're getting reliable steam, electrical, compressed-air services. And they'll save $480,000 per year. It's a typical example of . . .

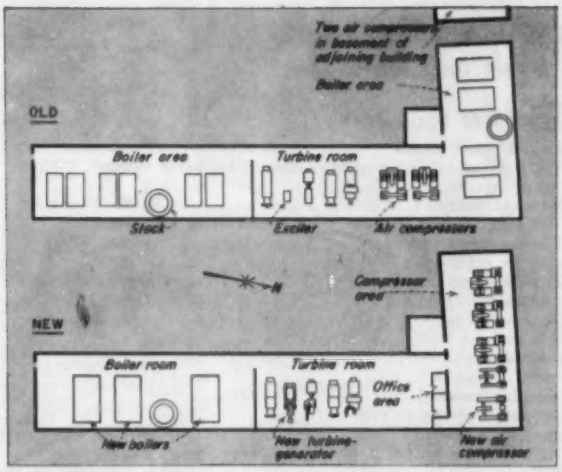
Why you can't afford not

► SELLING COMPANY OFFICIALS on the importance of modernizing power services is one of the really tough jobs that face today's power-service manager. His proposals often run into stiff competition from *quicker-return* propositions advanced by manufacturing engineers. But only when *all* the facts are considered—tangible as well as intangible—can top management make the right decision. Suppose, for example, an investment in power-service equipment will pay out in four years. Same expenditure for production machines, yielding similar savings, can be returned in three years. The missing fact in this picture might very well be: Risk of a costly production-department shutdown resulting from antiquated power-service equipment.

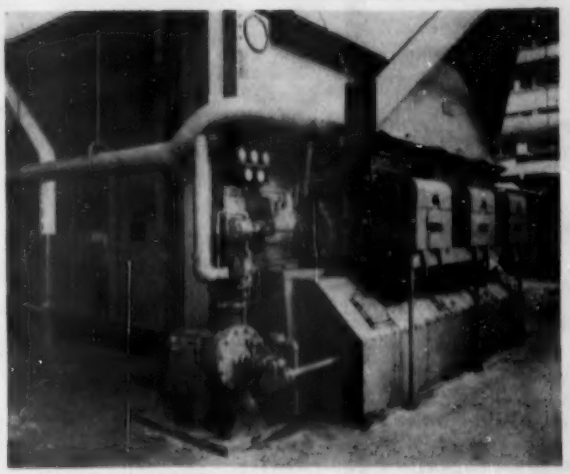
At Hudson Motor Division of American Motors Corp, the management carefully considered all facts relating to power-service modernization. Study by consultants Boddy, Benjamin and Woodhouse, Inc, investigated six separate action courses, ranging from complete shutdown of power-plant facilities (using purchased power and steam) to severance of tie-in with the local utility company. Fully informed, Hudson management chose a middle course. Their $2,900,000 investment for modernizing steam, electrical and compressed-air services promises to pay out in six years, leaving an annual saving of $480,000 thereafter. Even more important —they're well protected against costly service interruptions.

Plant-layout drawing, facing page, shows how new arrangement allocates available space for ease of operation. Consolidating two separate boiler areas in one spot, and supplying steam from three modern boilers instead of ten old units cuts back 3-shift boiler-operating force from 14 to 10. In

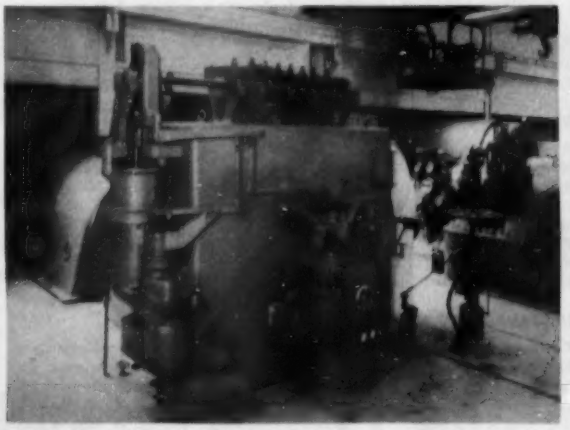
Information on which this article is based was furnished by M W Benjamin of Boddy, Benjamin & Woodhouse, Inc. We acknowledge his cooperation with thanks.



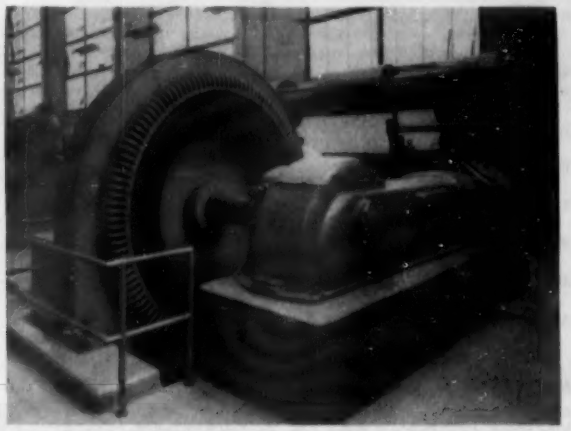
PLAN VIEWS of old and new equipment arrangement show how new setup makes improved use of available space, looks neater



SPREADER STOKER, traveling-grate type, receives coal from bunker through a conical distributor to three spreader units



3000-KW TURBINE, 600-psig throttle press., 175-psig back-pressure, drives a 3500-kw 4600-v delta-connected generator



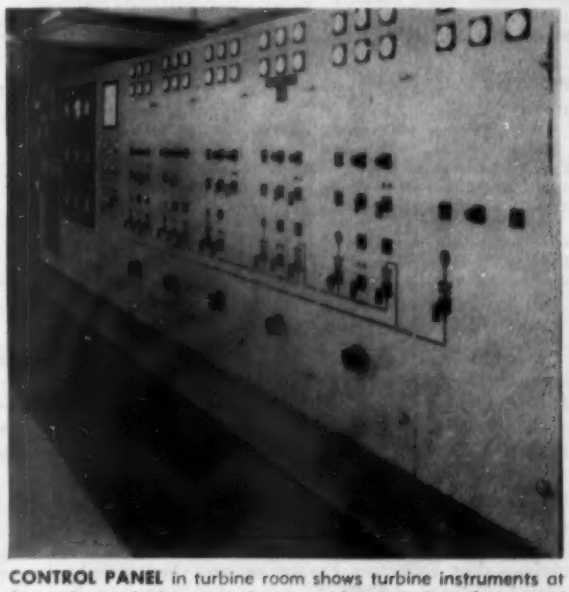
3600-CFM AIR COMPRESSOR, driven by 600-hp synchronous motor, boosts reliability of the existing compressed-air system

to modernize

addition, housing all air compressors in one location reduces its manpower needs from eight to six.

In planning the steam and condensate systems BB&W engineers worked out a 2-stage feedwater heating arrangement that permits generating practically all auxiliary power in mechanical-drive turbines—without exhausting steam to the atmosphere. Two boiler-feed-pump turbines operate between 600 and 60 psig, discharging steam to a second-stage closed feedwater heater. Six fan turbines, operating between 175 and 10 psig, help supply the deaerating heater and hot-process softener with low-pressure steam.

Three new boilers can each supply 100,000-lb-per-hr steam to a new 3000-kw topping turbine, two boiler-feed-pump turbines and a 600/175-psig pressure-reducing station. Flow quantities to each of these units depend on demand for process steam, electrical power. *(More on next page)*



CONTROL PANEL in turbine room shows turbine instruments at far end; six duplex control units with mimic bus, foreground

PRINCIPAL POWER-PLANT EQUIPMENT

Hudson Motor Division, American Motors Corp, Detroit, Mich.

POWER-GENERATING EQUIPMENT

Turbine-generator, 1 ..... General Electric Co
Turbine: 3000 kw, 3600 rpm, noncondensing, 600 psig, 725 F, 175-psig backpressure. Generator: 3500 kw, 4375 kva, 0.8 pf, 3 phase, 60 cycle, delta connected, 4600 v ungrounded

Exciter m-g sets, 4 ..... General Electric Co
To replace existing excitation system. One 15 kw, two 20 kw, one 30 kw

Exciter, direct connected, 1 ..... General Electric Co
25 kw, 125 v, 3600 rpm

Generator air coolers, 3 ..... Griscom Russell Co
To replace existing cooling system. Two 450,000, one 375,000 Btu per hr

Generator air cooler, 1 ..... General Electric Co

Air ejector, 1 ..... C H Wheeler Mfg Co
Two stage, to replace dry vacuum pump

STEAM-GENERATING EQUIPMENT

Boilers, 3 ..... Babcock & Wilcox Co
Two-drum Stirling, 100,000 lb per hr, 615 psig, 720 F, 9228-sq-ft surface, 85.3% efficiency. Economiser: 5200 sq ft

Stokers, 3 ..... Westinghouse Electric Corp
Traveling-grate spreader, 100,000-lb-per-hr steam, 10,450-lb-per-hr coal, 12,907 Btu per lb, 215 sq ft, 627,000 Btu per sq ft, cinder reinjection

Soot blowers, 6 ..... Diamond Power Specialty Corp

Induced-draft fans, 3 ..... American Blower Corp
51,900 cfm, 5.5-in. static pressure, 400 F

I-d-fan turbines, 3 ..... Elliott Co
168 hp, 175/10 psig, geared turbine

Forced-draft fans, 3 ..... American Blower Corp
25,500 cfm, 3.4-in. static pressure, 80 F

F-d fan turbines, 3 ..... Elliott Co
59 hp, 175/10 psig, geared turbine

Flyash collectors, 3 ..... American Blower Corp
Mechanical, two stage, 93% efficiency

Ash-conveying system, 1 ..... United Conveyor Corp
Pneumatic, steam jet, 15 tph

Ash bin and unloader, 1 ..... United Conveyor Corp
Tile, 141 tons

MISCELLANEOUS PUMPS

City-water booster pumps, 2 ..... Worthington Corp

Fire pump, 1 ..... Pearless Pump Div, Food Machinery & Chemical Corp

Fire-pump turbine, 1 ..... Elliott Co

Sulfite & phosphate pumps, 5 ..... Milton Roy Co

Desuperheater supply pumps, 2 ..... Worthington Corp

Heating condensate pump, 1 ..... Chicago Pump Co

Stoker oil pump, 1 ..... DeLaval Steam Turbine Co

ELECTRICAL

Primary switchgear ..... General Electric Co
7500 v, 250 mva, 20 feeders, 5 generators, 4-ring bus section, 1 utility tie unit, metalclad with magnetic circuit breakers

Duplex control units, 6 ..... General Electric Co

4600-v synchronous motor-control cubicles, 5 ..... General Electric Co

Secondary unit substation ..... General Electric Co
4800/480 v, 1000 kva, double ended, dry type

440-v motor-control centers, 6 ..... Westinghouse Electric Corp

Lighting, fluorescent ..... Westinghouse Electric Corp

FEEDWATER EQUIPMENT

Hot-lime-zeolite softener ..... Worthington Corp
1 hot-process softener, 3 pressure filters, 2 hot-zeolite softeners, 125-gpm outlet capacity

Boiler-feed pumps, 3 ..... Pacific Pumps Inc
378 gpm, 750 psig, 238 bhp, 7 stage, horizontally split case

Boiler-feed-pump turbines, 2 ..... Elliott Co
250 hp, 600/60 psig

Boiler-feed-pump motor, 1 ..... General Electric Co
250 hp, 3600 rpm, 440 v

Chemical-feed pump, 1 ..... } Worthington Corp
Brine pump, 1 ..... }
Backwash pump, 1 ..... }
Booster pumps, 2 ..... }
Deaerating heater, 1 ..... }
300,000 lb per hr, 10 psig }

Second-stage heater, 1 ..... Griscom-Russell Corp
280,000 lb per hr, 300 F, 60-psig shell press., 4-pass straight tube

COAL-HANDLING SYSTEM

Coal handling, 75 tph ..... The Jeffrey Mfg Co
Double-track hopper, double-plate feeder, 62-ft x 24-in. belt conveyor, reclaim hopper, reclaim vibrating feeder, 50-hp crusher, bucket elevator, three spiral conveyors

Storage bins, 3, 175 tons each ..... The Jeffrey Mfg Co

Conical coal distributors, 3 ..... Stock Equipment Co

VALVES

Blowoff valves, 18 ..... Yarnall Waring Co

Nonreturn valves, 3 ..... Edward Valves, Inc

Safety valves, 9 ..... Manning, Maxwell & Moore, Inc

600-lb steel globe valves ..... Edward Valves, Inc

600-lb steel gate valves ..... Crane Co

Pressure-reducing valves ..... Swartwout Co

Feedwater regulators ..... Northern Equipment Co

Level-control valves ..... Fisher Governor Co

INSTRUMENTS AND CONTROLS

Combustion control and instruments ..... Hays Corp

Desuperheaters and control ..... Swartwout Co

Level control ..... Fisher Governor Co

Pressure gages ..... H O Trerice Co; Manning, Maxwell & Moore, Inc

Boiler-level control ..... Northern Equipment Co

Level indicators ..... Yarnall Waring Co

Trouble annunciator ..... Autocall Co

Coal meters, 3 ..... Bailey Meter Co

Internal chemical treatment ..... Milton Roy Co

MISCELLANEOUS

Air compressor ..... Ingersoll-Rand Co
3600 cfm, 600 hp, 4800 v, synchronous drive

Air-intake snubbers, 5 ..... Burgess-Manning Co

Continuous blowdown system ..... Permutit Co

Chlorinator ..... Wallace & Tiernan Products Inc

Circulating-water strainer ..... Elliott Co

Building construction ..... The Barton-Malow Co

Piping and equipment erection ..... James W Partlan Co

Electrical construction ..... Howard Electric Co

Architects and engineers Boddy, Benjamin & Woodhouse, Inc

After study of firing methods, traveling-grate spreader stokers were picked. Factors favoring the choice were: It (1) responds to rapid load changes (2) burns a wide range of fuels including those with relatively high ash and moisture percentages (3) requires little attention (4) has low first cost.

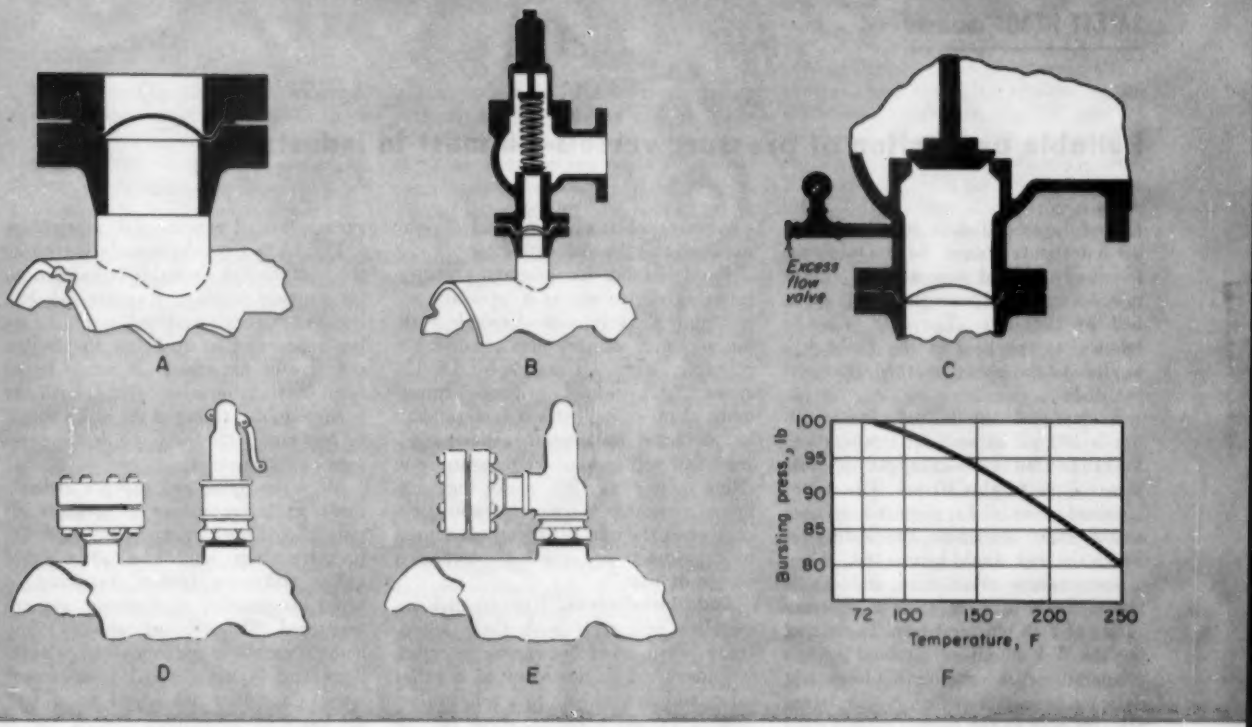
Boilers are also equipped with 2-stage cyclone dust collectors having an expected efficiency of 93%. An automatic vacuum ash conveyor removes collected flyash as well as bottom ash to a storage silo. Here, a rotary dustless unloader discharges it to trucks for final disposal. Vacuum conveyor is steam-jet design.

Completing new boiler-plant equipment are automatic combustion controls, new coal-handling system from track hopper to bunkers and a hot-lime-zeolite water-treating system for boiler makeup.

Topping turbine uses 600-psig throttle steam to generate byproduct power. Its 175-psig exhaust delivers steam to process, to existing low-pressure turbine-generators and to fan turbines. Although unit is tabbed at 3000 kw, it is capable of driving the 3500-kw generator at full load.

Compressed air's importance to Hudson's manufacturing departments dic-

(*Continued on page* 206)



1 ARRANGEMENTS for typical rupture disks, 1A-1E, for various types of pressure systems. The curve in 1F shows the effect of elevated temperatures on aluminum used for rupture disks

Part 2 of a series

By J F MYERS, *Manager, Safety-Head Division*
Black, Sivalls and Bryson, Inc

How to select and apply safety heads for protection of pressure systems

To choose the right rupture disk you must be familiar with Code requirements, effects of pressure and temperature, and typical arrangements. Here's a good look at these factors

► LAST MONTH, pp 94-95, we took a brief look at various types of prebulged and flat rupture disks. We are now ready to see how and where prebulged disks are applied in industry to protect pressure systems.

Code acceptance. Since the majority of closed pressure systems where rupture disks are adaptable are designed in compliance with the ASME *Unfired Pressure Vessel Code*, it is desirable to outline types of installations accepted by the *Code*, as well as their pressure limitations.

Paragraph UG-125 (Rupture Disks) in the 1952 edition (Section VIII) of the *Code* states, "Every rupture disk shall have a specified bursting pressure at a specified temperature, shall be marked with a lot number, and shall be guaranteed by its manufacturer to burst within 5% (plus or minus) of its specified bursting pressure. The specified bursting pressure at the coincident operating temperature shall be determined by bursting two or more specimens from a lot of the same material and of the same size as those to be used. The test shall be made in a holder of the same form and pressure-area dimensions as that with which the disk is to be used."

Clarification is needed for the statement, ". . . and shall be guaranteed by its manufacturer to burst within 5% (plus or minus) of its specified bursting pressure." When fabricating a pre-

*The recommended spelling *dish* is used throughout this article instead of *disc*. The author's firm uses *dish* to denote a flat plate, *disc* to denote a prebulged member. That distinction is not used in this article.

Reliable protection of pressure vessels—a must in industry

bulged rupture disk it is necessary to use a design tolerance. Such a tolerance is usually a fixed percentage (plus or minus) from the pressure rating specified by the user. The 5% (plus or minus) as specified in the *Code* then applies to the actual marked rating of the disk.

Example: If the desired rupture rating is 100 psi at ambient temperature, the range used in designing may be from minus 5 psi to plus 10 psi. The values obtained from disks ruptured in tests would then determine the rating at which the disk would be marked. When a temperature other than ambient is specified, the disk is given a pressure rating at both temperatures. The rating for the disk at either elevated or low temperatures is determined from test data we have established, which is applicable only to the ductile metals used in the prebulged disks of our design.

The *Code* further states, "The maximum pressure of the range for which the disk is designed to rupture does not exceed the maximum allowable working pressure of the vessel." Since, as previously stated, it is necessary to maintain an adequate margin between the normal working pressure of the system and the pressure rating of the disk, such a factor must be considered when the rupture-disk assembly is used on a *Code* vessel as the primary relief device.

Pressure vessels. Let's assume an unfired pressure vessel has a maximum allowable working pressure (design pressure) of 200 psi. If the normal operating pressure is 100 psi, pressure is considered static and the temperature is atmospheric, the pressure rating of the disk should be 150 psi at 72 F.

On the other hand, if the normal working pressure is 150 psi, or is a value that would place the disk rating above the 200-psi design pressure, it would then be necessary to use the disk assembly for secondary relief. However, inspection authorities will sometimes permit a deviation from the *Code*, particularly where it is desirable to use a rupture disk as the primary relief device.

If the rupture-disk assembly is to be used as a secondary pressure-relief device, supplementing a relief valve being used for primary service and with a setting not in excess of the maximum allowable working pressure, the pressure rating for the secondary relief device can, if necessary, be as high as the test pressure of the vessel, to obtain the desired margin between the actual working pressure and the disk rating.

Beside having the primary pressure-relieving device set at a pressure not exceeding the maximum allowable working pressure, we must also consider the relieving area. Paragraph UG-125 states, "All unfired pressure vessels other than unfired steam boilers shall be protected by pressure-relieving devices that will prevent the pressure from rising more than 10% above the maximum allowable working pressure, except when the excess pressure is caused by exposure to fire or other unexpected source of heat."

Code installations. Rupture-disk assemblies will meet with *Code* acceptance when used for primary relief, secondary relief, upstream of a relief valve, and downstream to a relief valve.

Fig. 1 further classifies these four arrangements of rupture-disk assemblies.

Fig. 1A is a typical installation where the rupture-disk assembly is being used for primary venting. Rupture-disk rating, as previously outlined, would be set for a pressure at or below the design pressure of the vessel. It would be so sized that any pressure rise (above the predetermined rating of the disk) would be less than 10% above the design pressure of the vessel.

Since the prebulged rupture disk affords an instantaneous as well as an unrestricted opening when ruptured, the pressure drop would be quite rapid unless unknown factors, resulting in rapid acceleration of pressure, are encountered. The relieving-capacity table, below, represents mathematical calculations and is not derived from actual tests. Capacities are based on a free discharge by the rupture disk.

Calculated relieving-capacity table for prebulged

	Rupture Pressure	¼"	½"	¾"	1"	1½"	2"	3"
	15							2,500
	25					680	1,530	3,340
	50			326	580	1,310	2,480	5,460
	75		260	452	685	1,810	3,440	7,560
	100	84	256	575	1,030	2,320	4,400	9,650
	125	78	312	704	1,250	2,820	5,350	11,800
	150	92	368	830	1,480	3,330	6,310	13,900
	175	106	423	955	1,700	3,820	7,260	16,000
	200	120	479	1,080	1,920	4,330	8,220	18,100
Schedule 40 Pipe Bore	225	134	535	1,210	2,140	4,840	9,180	20,200
	250	148	591	1,330	2,370	5,350	10,100	22,300
	275	162	646	1,460	2,600	5,850	11,100	24,400
	300	176	702	1,580	2,820	6,350	12,000	26,500
	325	190	758	1,710	3,040	6,850	13,000	28,600
	350	204	814	1,840	3,280	7,350	14,000	30,700
	375	218	869	1,960	3,480	7,850	14,900	32,800
	400	232	925	2,090	3,710	8,350	15,900	34,900
	425	246	981	2,220	3,930	8,860	16,800	37,000
	450	260	1,040	2,340	4,150	9,360	17,800	39,100
	475	274	1,090	2,470	4,380	9,860	18,700	41,200
	500	288	1,150	2,590	4,600	10,400	19,700	43,400
	550	316	1,260	2,850	5,050	11,400	21,600	47,500
	600	343	1,370	3,100	5,500	12,400	23,500	51,800
	650	371	1,480	3,350	5,950	13,400	22,400	56,000
	700	399	1,600	3,520	5,960	14,400	24,100	53,900
Schedule 80 Pipe Bore	750	427	1,710	3,770	6,370	15,400	25,800	57,500
	800	455	1,820	4,010	6,800	16,400	27,400	61,300
	850	483	1,930	4,260	7,200	17,400	29,100	65,100
	900	511	2,040	4,500	7,500	18,400	30,800	68,900
	950	539	2,160	4,750	7,900	19,400	32,500	72,700
	1,000	567	2,270	5,000	8,300	20,400	34,100	76,500
	1,100	623	2,490	5,490	9,120	22,400	37,500	84,000
	1,200	679	2,720	5,980	9,940	24,400	40,900	91,500
	1,300	733	2,940	6,440	7,830	21,100	33,000	81,300
	1,400	788	2,760	6,770	8,420	22,700	34,200	87,400
	1,500	843	2,950	5,110	9,020	24,300	36,500	93,500
	1,600	899	3,150	5,450	9,610	25,900	41,300	99,600
	1,700	955	3,340	5,790	10,200	27,500	43,000	106,000
	1,800	1,010	3,540	6,120	10,800	29,100	46,400	112,000
Schedule 160 Pipe Bore	1,900	1,070	3,730	6,460	11,400	30,700	49,000	118,000
	2,000	1,120	3,920	6,790	12,000	32,300	51,500	124,000
	2,500	1,400	4,890	8,470	15,000	40,300	64,300	155,000
	3,000	1,680	5,870	10,200	17,900	48,300	77,100	186,000
	3,500	1,960	6,850	11,800	20,900	56,300	89,900	217,000
	4,000	2,240	7,820	13,500	23,900	64,400	103,000	249,000
	4,500	2,520	8,800	15,200	26,900	72,400	115,800	279,000
	5,000	2,800	9,770	16,900	29,800	80,400	128,000	310,000
	5,500	3,080	10,800	18,600	32,800	88,400	141,000	341,000
	6,000	3,360	11,700	20,300	35,800	96,500	154,000	372,000

Series use. Fig. 1B shows a rupture-disk assembly used in series with a relief valve. This arrangement can be used for either primary or secondary service. Here again we must consider the margin to be maintained between operating pressure and disk rating. If the operating-design pressure range of the vessel does not permit the tolerance required to use the rupture member in conjunction with the relief valve as the primary combination, but it is still desirable to use a rupture disk, we suggest the arrangement in Fig. 1D.

Here the relief valve is used as the primary vent and the rupture disk as secondary. The disk assembly then serves as a standby—affording a full flow area when the pressure rises to the disk rating. This type of installation is desirable where corrosive, viscous or gummy substances may make the valve inoperative. Atmospheric conditions may also affect the proper functioning of the relief valve.

If the design pressure of the vessel permits the use of a rupture disk in series with a relief valve and the required tolerance between operating pressure and disk rating can be maintained, a desirable arrangement is secured because the rupture disk isolates the valve mechanism from the product within the vessel.

Downstream location. The *Code* also permits use of a rupture disk on the downstream side of a spring-loaded safety or relief valve, provided, as in paragraph UG-127, "the valve is so constructed that it will not fail to function at its proper pressure setting regardless of any backpressure that can accumulate between the valve disk and the rupture disk."

This means the valve should be a bellows, diaphragm or piston type, thereby providing a balanced condition if there is an accumulation of pressure in the chamber between the valve seat and the rupture disk, Fig. 1E.

In an installation like that in Fig. 1B, a telltale indicator should be installed between the rupture disk and the valve plug. If the type of product in the vessel makes it undesirable to have an open vent to the atmosphere after the disk ruptures and the valve reseats, an installation like that in Fig. 1C may be desirable. When the disk ruptures, the ball check valve is immediately closed. The gage indicates the pressure, either before or after the valve has functioned, indicating to the operator that the disk is ruptured.

Since any accumulation of pressure in the chamber between the rupture disk and the valve plug would affect the rupture-disk rating, it is important to make some provision to maintain only atmospheric pressure within this chamber. The open bleed line or the arrangement in Fig. 1C is preferable to a try cock or other types of pressure indicators.

Selection factors. One of the most important factors, tolerance between the actual operating pressure and disk rating, has been discussed. Other factors include the normal temperature encountered at the disk location, pressure conditions (static or pulsating), amount of vacuum or backpressure to which the atmospheric side of the disk will be subjected, and metals that are not affected by corrosion—either from the product within system or from the atmosphere.

All ductile metals, used in fabricating preformed rupture disks, except Inconel, have their strength reduced by elevated temperatures up to 650 F. So it is extremely important to take into consideration the anticipated normal temperature when the disk is designed.

For example, if the vessel or system normally operates at a 50-psi static pressure and a temperature of 250 F, it is desirable to use a rupture disk for 100 psi at 250 F, thereby increasing the pressure rating at ambient temperature. If the elevated temperature is not taken into consideration and a disk is specified for 75 psi at ambient temperature, the metal has reduced strength at 250 F. This lowers the tolerance between the normal operating pressure and the desired pressure rating for the disk. The same condition applies to metals subjected to minus degree temperatures.

Metals that can be satisfactorily used in fabricating prebulged disks, and designed for a specific pressure rating at a minus degree temperature, increase in strength as the temperature is lowered. To compensate for the strength increase, the pressure rating of the disk at ambient temperature must be reduced.

Limits have been established on all ductile metals we use in fabricating prebulged rupture disks. For aluminum, copper and silver, maximum operating temperature is 250 F; for platinum and stainless steel (321, 347 and 302) it is 600 F; monel, 800 F; Inconel, 900 F.

NOTE: *Caption, Fig. 4, Jan, p 95, should be: Positive pressure and vacuum defeat purpose of flat-type support*

safety heads of given diameters on pressure vessels

4"	6"	8"	10"	12"	14"	20"	24"	
4,320	9,780	16,900	26,700	37,900	59,800	94,100	136,000	
5,760	13,100	22,760	35,700	50,500	80,000	126,000	182,000	
9,410	21,300	37,000	58,200	82,500	130,000	205,000	297,000	
13,100	29,600	51,300	80,900	115,000	181,000	285,000	412,000	
16,780	37,900	65,800	103,000	147,000	232,000	364,000	527,000	Schedule 40 Pipe Bore
20,300	46,100	79,900	126,000	179,000	282,000	444,000	641,000	
24,000	54,400	94,100	148,000	211,000	332,000	523,000	756,000	
27,600	62,600	108,000	171,000	242,000	382,000	602,000	870,000	
31,300	70,900	123,000	193,000	274,000	433,000	681,000	985,000	
34,800	79,100	137,000	216,000	306,000	483,000	760,000	1,100,000	
38,400	87,300	151,000	238,000	338,000	533,000	840,000	1,210,000	
42,000	95,500	166,000	260,000	370,000	584,000	920,000	1,330,000	
45,600	104,000	180,000	283,000	402,000	635,000	1,000,000	1,310,000	
49,300	112,000	194,000	306,000	434,000	685,000			
53,000	120,000	208,000	328,000	466,000	735,000			
56,600	128,000	222,000	350,000	498,000	785,000			
60,200	137,000	237,000	373,000	530,000	836,000			
63,800	145,000	251,000	395,000	510,000	886,000			
67,400	153,000	265,000	417,000	539,000	852,000			
71,000	161,000	280,000	440,000	567,000	899,000			
74,600	170,000	294,000	462,000	595,000	945,000			Schedule 80 Pipe Bore
81,900	186,000	323,000	507,000	654,000	1,035,000			
89,100	202,000	352,000	552,000	712,000	1,125,000			
97,120	198,000	348,000	544,000					
93,600	213,000	372,000	585,000					
100,000	228,000	398,000	626,000					
107,000	242,000	424,000	667,000					
113,000	257,000	450,000	708,000					
120,000	272,000	476,000	749,000					
126,000	287,000	502,000	790,000					
133,000	302,000	528,000	831,000					
146,000	332,000	580,000	913,000					
159,000	362,000	632,000	995,000					
139,000								
158,000								
166,000								
171,000								
181,000								
192,000								
203,000								
213,000								Schedule 160 Pipe Bore
266,000								
319,000								
372,000								

Explanation of Relieving Capacity Table

Cubic ft of free air per min at 60 F & 14.7 psi abs. Air inlet temp of 60 F.; discharge coeff of 0.62. Assumed that SAFETY HEAD is mounted on a vessel and not in a line.

To obtain approximate relieving capacities for gases other than air, multiply values in above table by $F = \sqrt{\frac{1}{sp.\ gr.}} = \sqrt{\frac{29}{M}}$ —where sp gr = specific gravity of the gas referred to air as 1.00 and M = molecular weight of gas.

These figures represent mathematical calculations only and are not derived from actual tests.

Check up on the boiler auxiliaries for handling air and water

Air and water, like fuel, are indispensable to operation. Here's a rundown on essential air-handling equipment, plus a look at the all-important boiler feed pump

By D C SWIFT, *Ebasco Services Incorporated*

►FOR BOILER OPERATION, you must insure air supply to the furnace, and water to the boiler. Air is necessary for burning fuel and for removing the products of combustion. Water keeps the boiler from burning up, and turns into steam for power or process.

The air-moving units can be used singly or together. They include chimneys, breechings, induced- and forced-draft fans. We'll also briefly discuss dust collectors and boiler feed pumps.

Chimney has two functions: It discharges combustion products to the atmosphere, and provides draft to help pull hot gas out of the boiler. Height must be adequate to keep gas from being a nuisance to the community and to produce enough draft. You should have a slight suction in the furnace when boiler operates at full load, unless the setting is designed to operate under pressure.

Diameter of chimney and connecting breeching must be big enough to carry the gas volume without requiring excessive gas speeds.

Make sure chimney is firmly supported and anchored to resist high winds. It also needs lightning protection. If it projects above surrounding objects, airplane warning lights may be required. Check with Civil Aeronautics Authority.

When cooling, most flue gas forms deposits that are corrosive to metal. Check metal stack construction to see that you have a lining to guard against overheating lower sections of stack or corroding upper sections. Corrosion tendency depends on amount of water vapor and sulfur dioxide in the gas, and on how much gas temperature is lowered by boiler, economizer and air heater, and by breeching and chimney radiation. Be sure there is provision for expansion and contraction of brickwork.

Before using a new chimney, inspect carefully to see that it is clear and without serious cracks or imperfections. If there is much brickwork, dry it out slowly by either building a slow wood fire in the chimney base, or operating boiler at light rating for a day or two.

After chimney has dried, inspect it with binoculars. Record any cracks or defects so you will have a comparison for findings from subsequent inspections. Tightly seal the access door at the stack base when chimney is put into normal operation.

Other things to check include dust hoppers, valves and piping; see that they are clear and work freely. Try out flyash-removal equipment to see that it is complete and in good working condition. If you have a connection for a draft gage, it will be convenient, and may make useful information available.

Breeching is the duct from boiler or induced-draft fan outlet to the chimney. Check for tightness, proper support, provision for expansion and proper attachment to boiler and chimney. Try out dampers to see that they operate easily, close completely and have clearance for expansion under heat.

Inspection doors should be located so you can blow out flyash deposits with boiler in operation, if necessary. As boiler warms up, observe breeching to see that expansion occurs properly.

If leaving flue gas is below 300 F, check occasionally to be sure there is no corrosion on breeching plates. When boiler is shut down, clean out this duct promptly to keep sulfur-containing flyash from corroding the metal.

Induced-draft fans commonly furnish additional draft for boilers. Make careful inspection, checking the following:

Are blades and fan housing liners firmly attached, and fan housing and connecting duct work clean and free of debris? Is rotor set so blade curvature is in the proper direction?

Is fan cut off reasonably close to blade tips? Clearance between stationary and moving parts of fan seals at the gas inlet evenly spaced? Not too small for adequate clearance when hot, but not so large that excessive leakage or recirculation occurs?

Use correct type and quantity of lubricant in fan and driver bearings and flexible coupling. Check fan alignment and set with proper allowance for differential expansion of fan, driver and gear or coupling. Recheck alignment

with units close to normal operating temperature. Check fan shaft seals as boiler is brought up to rating to see that they are not rubbing too hard. This could cause bearing to overheat.

Try out the fan momentarily to be sure it turns in the intended direction. But do not run it long. An induced-draft fan is designed for hot gas. Operation on cold air seriously overloads the driver, particularly a motor, if dampers are opened very far. It's advisable to check motor current and establish a point of maximum allowable damper opening for operation with cold air.

Control dampers or vanes at induced-draft fan inlet and outlet may cause trouble, either from sticking or incomplete closing. Damper blades should all close at the same angle and as completely as possible; blade ends need clearance to prevent binding when hot.

Remove any excessive play in damper linkage and in connection to automatic control, if used. Mark extreme open and closed position of dampers. If you use any lubricant on damper bearings, have it suitable for high-temperature. Where flyash can gain access to the bearings and mix with the lubricant, it is often better not to lubricate. Particularly if exposed to weather, bearings should be designed to prevent flyash leaking from the inside or water from the outside.

Sometimes inlet and outlet dampers must be used together to restrict gas flow through boiler when lighting fires or operating at low loads. With a double-inlet fan, you may have enough play between the two sides of the damper operator so one side is closed while the other is still partially open. To correct this, adjust blade angles or use a weighted arm to take up slack between the two halves of control drive.

Forced-draft fans also need careful internal inspection, and must be aligned to compensate for probable temperature differences. Before operating, check type and amount of lubricant and rotation direction. See that dampers and control mechanism have free movement, and close completely.

Plainly mark the extreme open and closed positions for the dampers. Put screens over fan inlets to keep out rags or debris that might damage or unbalance the fan.

Other fan controls include variable-speed couplings or variable-speed motors or turbines. These units are sometimes used instead of or supplementary to fan control dampers.

Each type of equipment has its own problems. To insure best operation, read and observe manufacturer's instructions carefully. Check electrical connections, mechanical alignment, lubrication.

Dust collectors are usually installed between the boiler and the induced draft fan. This reduces wear on fan blades and liners as well as cutting down on dust sent to atmosphere. Collectors can be mechanical or electrical or a combination.

Before putting into operation, make a complete final check. Is unit clean inside? casing tight? elements properly positioned? electrical elements insulated right? provision for expansion? means for dust removal? draft and test sampling points properly located?

If shutoff and bypass dampers are provided, check for tightness of closing, provision for expansion under heat and completeness of travel. Be sure open and closed positions of dampers are plainly marked and means for positioning dampers are adequate.

Should you have a fan in the dust-collector assembly, make the usual precautionary checks for alignment, lubrication and cleanliness. For electrostatic equipment, check transformers, rectifiers and auxiliary and control apparatus before putting into service.

It's important to have means for indicating amount of dust in collector hoppers, and a schedule for frequent removal. This prevents enough dust accumulating to interfere with collector operation. It is especially important in initial operation when pulverizers, stokers or furnaces may not be running properly and larger than normal amounts of flyash may be handled.

Low-temperature flue gas sometimes condenses enough moisture to cake the dust, seriously interfering with collector operation. It may be helpful to bypass collectors or keep them warm during very low load or idle periods, if feasible for the installation. Read draft gages regularly to find out condition of collectors, and check on efficiency and performance at regular intervals.

Boiler feed pumps may be the most important auxiliary for safe boiler operation. If pump isn't running properly, the whole plant may be shut down.

The larger high-pressure centrifugal pumps usually run at high speeds with close clearances. They must be carefully assembled and operated to run right.

Most feed pumps are shipped assembled; don't open unless you think something is wrong inside. After setting up and grouting in, check alignment between pump and driver, making allowance for location of bearing supports and probable temperatures in calculating differential expansion of the two or more elements.

To avoid damage to pump, thoroughly clean the feedwater storage tanks and feed-pump suction piping. If possible, flush out with water before connecting to pump suction.

After unit is set and aligned, make up the suction and discharge lines so strain on the pump is a minimum, especially at normal operating temperatures. Suspend pipes by flexible hangers or spring supports. Recheck pump-driver alignment after making up the piping.

Put a readily removable strainer in each pump suction, with a pressure gage tapped in on both sides of the strainer. If gage shows increased pressure drop, flow is restricted.

At first, cover strainer with a ¼-in. or finer mesh screen. After running a few hours at fairly high flow, you need only the coarser mesh strainer (say ½ or ¾ in.), as much of the fine dirt will be flushed out.

Remove the strainers when miscellaneous piping and all heaters are in service at maximum loads and all loose dirt is washed out. This avoids possible pump starvation or disintegration of the strainer.

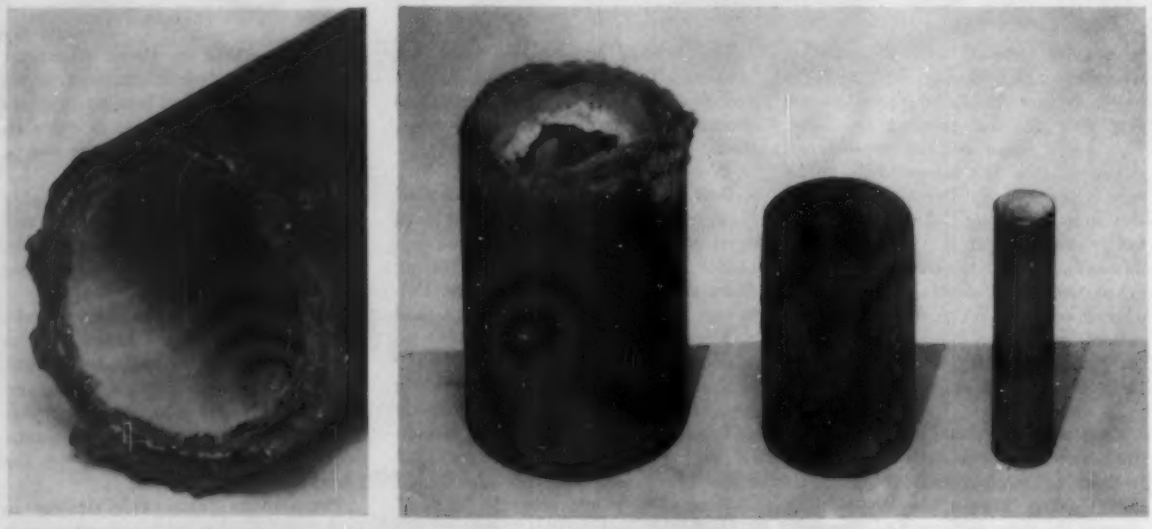
Clean strainers often while in service, to (1) keep pump suction pressure 3 to 5 psi above the pressure corresponding to incoming feed temperature, and (2) insure that suction pressure never falls below atmospheric.

You need a minimum flow rate through any large centrifugal pump to avoid overheating and binding. This minimum flow is usually controlled by one or more orifices in series in a recirculating line connected to the discharge. Water returns to the suction tank or other place where heat can be dissipated.

Before bringing pump up to speed, check the arrangements for cooling with no water flowing to boiler. Trace valves and piping to be sure pump will be protected as intended.

During initial operation and for a short while afterwards, keep recirculating lines open at all times. When operation settles down into a routine, you can make substantial power savings by running with recirculating line normally closed. Be sure operators know they must open recirculating lines promptly if flow decreases to a minimum that is

(*Continued on page* 202)



Scale can cause severe boiler damage if water tests and

Stop scale formation in your boiler

Solubility is the key to scale and sludge problems. Protection comes from changing scale-forming salts into sludges that are easily blown down before these salts saturate the water

► EXTERNAL WATER CONDITIONING removes the bulk of scale-forming salts. But no system is as yet foolproof against scale formation without additional internal treatment. Slight residual hardness rapidly accumulates inside boiler drums through continued water concentration.

When water boils to give steam, most mineral matter remains. Commonly known as scale and sludge, both are basically identical. Scale forms as an adherent deposit on the water side of the boiler heating surface. Sludge shows up as loose circulatory formations.

Scale and sludge both form in the following manner:

- Decomposition of soluble compounds to less soluble compounds.
- Precipitation of compounds whose solubilities decrease with temperature rise.
- Precipitation of compounds whose solubilities are exceeded by boiler-water concentrations.

Water composition and concentration vary scale formation as to density, adherence and porosity. Calcium and magnesium form soft, chalky scales. Calcium sulfate produces adherent hard scale.

Calcium carbonate. Hot water, free from carbon dioxide, holds 13 ppm calcium carbonate. Cold water, containing carbon dioxide, dissolves about 906 ppm calcium carbonate, which becomes calcium bicarbonate. In a boiler, heat drives off carbon dioxide with steam, and bicarbonate returns to carbonate. Excess over 13 ppm calcium carbonate precipitates.

Low-alkalinity calcium-carbonate scale is very sticky and adherent. It usually deposits in cooler boiler sections rather than in tubes and its sludge is easily handled by blowdown.

Calcium sulfate has a solubility of 1290 ppm in 32 F water, but its solubility drops sharply to about 84 ppm at 360 F. Modern methods of chemical treatment precipitate calcium salts in some other form than calcium sulfate. Scale with quantities of calcium sulfate shows inadequate or improperly applied water treatment. Sulfate scale-control test is shown in table II, p 108.

Calcium silicate. Natural alkaline waters usually carry more silica than normal. Also, hot alkaline waters dissolve silica in sand filters. And calcium and silica combine to form calcium-silicate scale, which is glassy, extremely hard, and has high heat insulation.

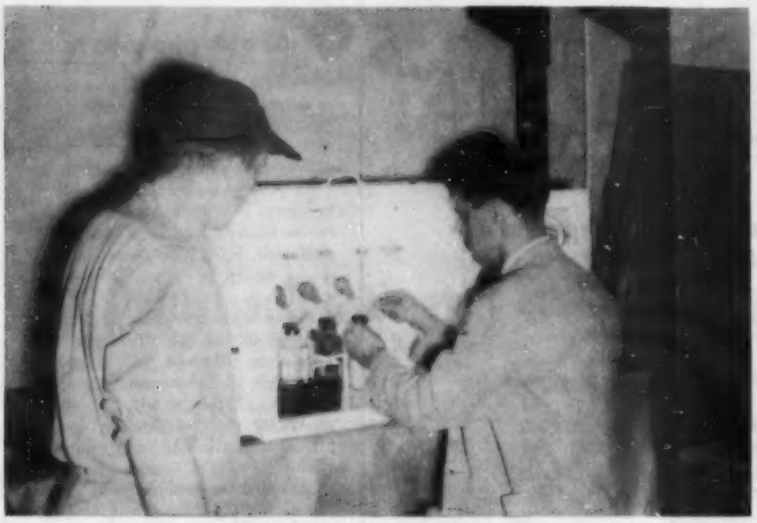
Analcite. Between the temperatures 350 and 800 F, analcite (a sodium aluminosilicate scale) forms when silica and soluble alumina are present in the boiler water. This scale can form with small amounts of silica present, only a few parts per million being needed. Here again the scale has very low heat conductivity.

Magnesium. Under heat, magnesium bicarbonate decomposes to form magnesium hydroxide, which is much less soluble than magnesium carbonate. With adequate silica present, magnesium hydroxide combines and precipitates as slightly soluble magnesium silicate.

Magnesium hydroxide forms a sticky sludge inside boilers. Magnesium silicate usually sludges and is easily blown down.

Solubility. Table I, p 108, shows relative solubilities of common chemical compounds. Data are for solution of a particular compound in pure water. Presence of several salts in the water

STOP SCALE continued



By L W FITZPATRICK, *Chief Engineer*
Department of Corrections
Jefferson City, Missouri

conditioning fall down, so...

with proper treatment

would alter solubilities in table appreciably. For instance, sodium salts lower calcium-sulfate solubility.

Sodium salts, being extremely soluble in both cold and hot water, do not scale unless evaporation is carried out to the extreme. Boiler-scale formation always remains a function of the decrease in the compound's solubility with increase in temperature. When solubility limit of a scale-forming compound is passed by one means or another, excess crystallizes at the boiler-wall surfaces from supersaturated boiler water.

Since scale-forming salts decrease in solubility with increase in temperature, scaling can take place even when body of water is only saturated with the salt. This is possible because of the greater temperature in the boiler-water film at heating surfaces. Boiling is not necessary for this crystallization. However, most scale forms as minute crystals in rings where bubble edges touch the surfaces on which boiling is taking place. Once scale crystal is started, it may grow further by contact with supersaturated water, or additional layers may form when initial layer is protected by film of another substance.

Rate of heat input at the surface where scale is forming is a contributing factor. Analcite scale is associated with high-heat-input areas; calcium-carbonate scale usually forms in lower-heat-input locations. Boiler-water velocity also has a slight influence on scale formation.

Scale is decidedly more serious in a watertube boiler than in an hrt firetube boiler. Scale 1/16 inch thick almost always means trouble in water tubes exposed to radiant heat. But heavy deposits on firetubes mean only loss of efficiency without any extreme danger.

Internal chemical treatment. Successful water conditioning calls for eliminating the causes of scale—primarily calcium and magnesium salts. Internal treatment to make calcium precipitate as calcium phosphate is *phosphate control*. *Carbonate control* uses soda ash (sodium carbonate) to make calcium precipitate as calcium carbonate.

Carbonate control. Soda ash breaks down to caustic soda at high temperatures. This requires feeding excessive amounts of soda ash to maintain adequate carbonate radical (CO_3), continually raising total alkalinity. It becomes impossible to maintain essential sulfate/alkalinity ratios with carbonate control. And high dissolved solids and excessive hydroxides will form to nullify caustic embrittlement protection.

Phosphate control. While roughly three times as expensive as carbonate conditioning, phosphate offers added advantages in over-all operation offsetting the higher cost.

Phosphates have the edge over the carbonate system for removing calcium hardness in that they remain stable. And they keep no-scale conditions without excessive alkalinity. Calcium phosphate is less soluble than calcium carbonate, the endpoint of carbonate control. So there are less calcium ions available for scale formation with phosphate system.

Calcium phosphate differs from other calcium salts in that it does not grow and interlock to form scale. Instead, a finely divided sludge forms, which, when kept fluid, is easily removed by blowdown. Usually organic compounds, such as tannins and lignins, are used with both phosphate and soda-ash treatments. These substances generally disperse sludge so it cannot settle—but action cannot be predicted and selection and dosage must be determined by experiment.

Phosphates generally used are either simple or complex sodium salts. Regardless of the type employed, reaction with calcium is the same for all. Phosphates under heat revert to trisodium phosphate. This reacts with calcium salts to form tricalcium phosphate.

Every phosphate, when dissolved in hard water, reacts with calcium and magnesium salts, precipitating them as insoluble salts. The buffered phosphate alkalinity is then free to act in its detergent capacity. The delayed buffering action gives it the effectiveness of caustic soda without the latter's corrosive action.

Phosphate selection depends on economics and boiler-water alkalinity. High-carbonate feedwater hardness favors disodium acid phosphate to lower the alkalinity. On the other hand, trisodium alkaline phosphate holds the water at desired alkalinity.

Most commercial sodium-phosphate treatments for use up to 2200 psig are blended with a 54% phosphate content, and a 5% solution averages 8.0 to 8.2 pH. Generally a blend of both acid and alkaline is used rather than a single phosphate.

Sufficient alkalinity must be maintained with phosphate control because calcium phosphate becomes more soluble with low alkalinity, forming a sticky adherent sludge. Adequate alkalinity for complete reaction with calcium requires a minimum pH of 9.6 in a steaming boiler. This is equal to

I: Solubility of some chemical compounds found in water treatment*

Chemical compound	Parts per million as $CaCO_3$ 32 F	212 F
Calcium		
Bicarbonate	1,620	Decomposes
Carbonate	15	13
Chloride	336,000	554,000
Hydroxide	2,390	888
Sulfate	1,290	1,250
Magnesium		
Bicarbonate	37,100	Decomposes
Carbonate	101	75
Chloride	362,000	443,000
Hydroxide	17	8
Sulfate	170,000	356,000
Sodium		
Bicarbonate	38,700	Decomposes
Carbonate	61,400	290,000
Chloride	225,000	243,000
Hydroxide	370,000	970,000
Sulfate	33,600	210,000

II: Scale-control test for sulfate

Feedwater = chlorides (C_f) and sulfates (S_f)
Boiler water = chlorides (C_b) and sulfates (S_b)

Formula No. 1

$\frac{S_b}{S_f}$ equals $\frac{C_b}{C_f}$ — No sulfate scale is depositing

Formula No. 2

$\frac{S_b}{S_f}$ greater than $\frac{C_b}{C_f}$ — Former sulfate scale being removed

Formula No. 3

$\frac{S_b}{S_f}$ less than $\frac{C_b}{C_f}$ — Sulfate scale forming. Hardness will be present in boiler water

about 10.5 pH at room temperature. The "P" alkalinity must be greater than one half the "M" alkalinity, and the "M" value should be at least 200 ppm.

Calcium combines with phosphate in the ratio of 120.24 to 142.04, forming calcium phosphate, $Ca_3(PO_4)_2$. So each pound of calcium hardness requires about 1.18 pound of actual phosphate.

As an example, monosodium phosphate contains 58.5% actual phosphate. To precipitate one pound of calcium hardness: 1.18 ÷ 0.585 = 2.02 lb of monosodium phosphate are needed.

No set figure has been definitely established for phosphate ratio. Some plants with efficient feedwater hardness control operate with a low 10 to 30 ppm excess. Others with regular feedwater contamination require up to 70 ppm. Generally 100 ppm is the upper limit because high phosphate increases the chance of magnesium scale formations. Increasing alkalinity instead of phosphate precipitates magnesium as the more desirable hydroxide. With silica present, magnesium combines as magnesium silicate, a fluid sludge easily handled.

Calcium phosphate scales with high-hardness makeup water. This produces considerable sludge accumulation at points of slow circulation in the boiler. Once formed, additional phosphate does not remove it, and chemical or turbine cleaning must be used for removal.

Phosphate will remove some old scale formation under careful control held at 20 ppm. Carbonate and sulfate scales respond readily, but silica groups are highly resistant, withdrawal rate is slow.

Generally scales with high calcium content react with phosphate, forming calcium-phosphate sludge. Disintegration of the calcium portion causes the entire scale to break up.

As every boiler acts as a high-temperature hot-process softener in operation, low hardness in makeup water substantially reduces precipitation with the result that fewer blowdowns are needed.

About phosphate

Phosphate rock, called phosporite, is mined extensively in South Carolina, Florida, Canada and Spain. The rock is reduced to elemental phosphorus in electric furnaces.

As pure phosphorus is not soluble in water, it is then burned with an excess of oxygen to form phosphorus pentoxide, P_2O_5. This compound dissolves easily in water to produce acids.

These acids are then neutralized for commercial use with soda ash. This gives either an acid phosphate with high phosphate content, or an alkaline phosphate with a smaller phosphate ratio, depending on the pH neutralization by soda ash.

The pH ranges required in industrial processes include acid phosphates for fertilizers; neutral phosphates for many cleaning compounds; alkaline phosphates in detergents, dye stuffs, paint pigments, leather tanning, cattlefood supplement and patent medicine.

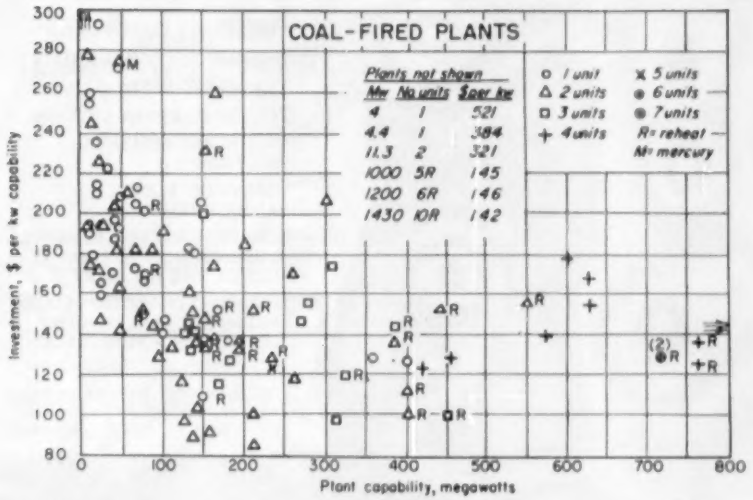
*From book, "Water Treatment for Industrial and Other Uses," by Emil Nordell, published by the Reinhold Publishing Corporation.

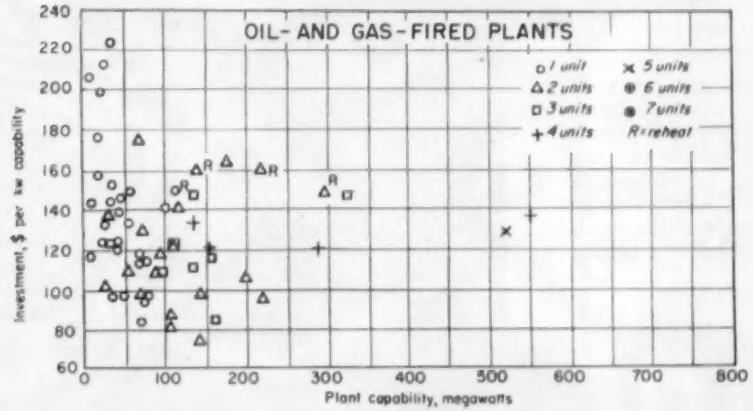
Power's DATA SHEET

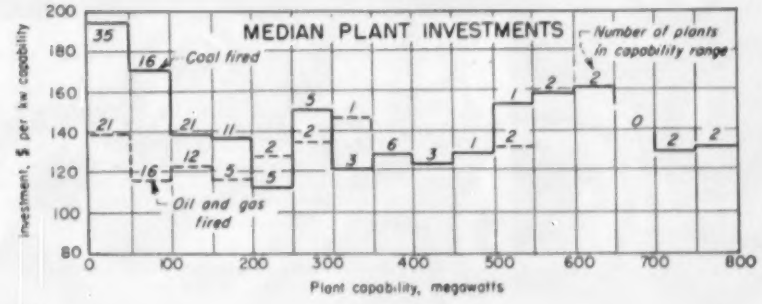
No. 272

Actual and estimated new central-station investments

1945-1954







► LAST MONTH's data sheet gave new central-station investments by states. The national average worked out to $141 per kw net capability. These graphs give the same data plotted against plant capability. Where plant capability figures were not available, it has been assumed that it equaled 1.1 x nameplate capacity of the units.

About 63% of the investment is estimated. The remainder represents final total capital cost. The upper graph shows variation for coal-fired plants only, the middle graph for oil- and gas-fired plants. The lower graph gives the median investments of both types for 50-mw ranges of capability. Legends show the number of units in each plant.

Wide variation in investments depends on locality, price level at time of construction, overtime labor, provisions for future capacity expansions, and many other factors. Despite the estimates involved in these figures they can be used as a good guide to actual costs of today's *new* central-station steam-electric generating plants.

—B G A SKROTZKI, *Associate Editor*

Source: Federal Power Commission

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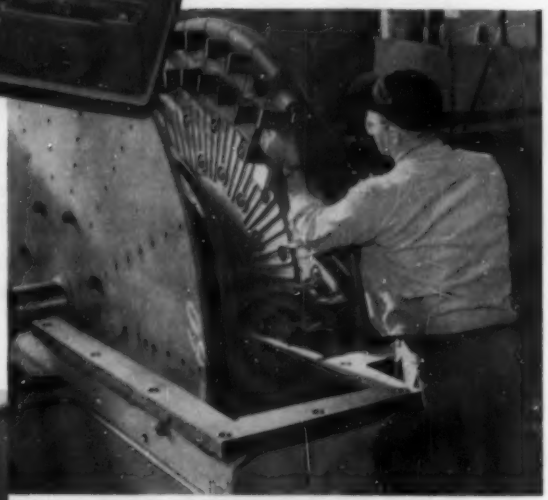
- CRUSHER BLOCK ADJUSTMENT
- OIL STORAGE FOR BEARING LUBRICATION SYSTEM IS INSIDE THE PEDESTAL
- PULVERIZER SECTIONS ARE MOUNTED INDEPENDENT OF BEARING PEDESTALS

*Can be provided mounted on pulverizer, or separately on floor above.

Latest Model #350 Single Pulverizer with Feeder

Riley has manufactured coal pulverizers since 1925. In 1950 the Riley "50" Pulverizer Series was introduced. Tough, durable Tungsten Carbide applied to pulverizing parts provides extra long continuity of service and low maintenance even with high ash coals. In addition, a crusher-dryer section precrushes the coal, rejects foreign material, and flash-dries the wettest coals, with the result capacity is maintained. Illustration at right shows moving pegs and the pulverizer's accessibility.



#550 Duplex Leaves Riley's Detroit Plant for Colorado

The #550 Duplex, the largest model, is actually a combination of two #550 Single Pulverizers and has a 46,000 lbs/hr rated capacity with 50 grindability coal. Public Service Co. of Colorado has installed seven of these units. Detroit Edison Company has ordered six Duplex Units for a steam generating unit with a capacity of two million pounds per hour.

Cross section of typical #550 Duplex Pulverizer. Coal enters crusher-dryer section (at ends) — here it is precrushed, flash-dried and tramp iron is rejected. Coal is pulverized to required fineness in second sections by attrition. Coal, uniformly mixed with air is blown to burners (center sections).

RILEY DESIGNS, MANUFACTURES AND INSTALLS COMPLETE STEAM GENERATING UNITS AND

"50" PULVERIZER

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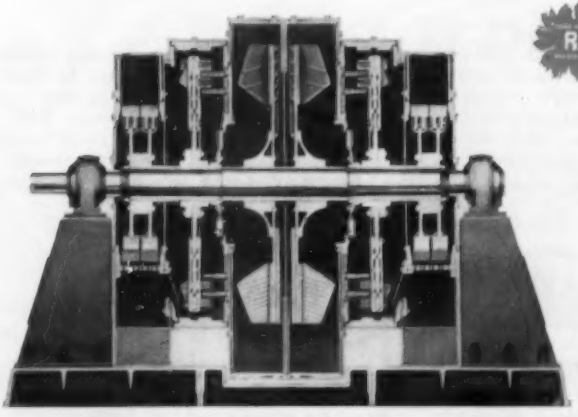
- Small, overall space
- Low foundation cost
- No loss of capacity with wet coal
- Extreme load range
- Insignificant Btu loss with rejections
- Insignificant handling cost of rejections
- Ease of maintenance
- No adjustments required to maintain fineness
- Low cost maintenance with high ash coals
- Ability to use high primary air temperature with increase in efficiency
- Minimum of lubricating difficulty
- Ease of automatic regulation
- No auxiliary air required for sealing
- Minimum explosion and fire hazard
- Rapid response to load change

*Public Service Co. of Colorado	7-550	Duplex
	1-450	Single
	1-350	Single
*Detroit Edison Co.	7-550	Duplex
Columbus & Southern Ohio Elec. Co.	4-550	Duplex
*Hartford Electric Light Co.	4-550	Duplex
Potomac Edison Co.	3-550	Duplex
Monongahela Power Co.	3-550	Duplex
Northern States Power Co.	3-550	Single
Iowa Electric Light & Power Co.	9-550	Single
Taiwan Power Co.	3-550	Single
Superior Water, Light & Power Co.	2-450	Single
Upper Peninsula Generating Co.	2-550	Single
Utah Power & Light Co.	4-550	Single
Western Colorado Power Co.	2-350	Single

. . . and these public power stations

Dairyland Power Co-op., Alma, Wis.	3-550	Single
City of Owensboro, Kentucky	3-550	Single
City of Richmond, Indiana	3-550	Single
South Carolina Public Serv. Auth.	6-550	Single
Corn Belt Power Co-op.	2-550	Single
City of Austin, Minn.	2-550	Single
City of Rochester, Minn.	2-550	Single
City of Holyoke, Mass.	2-450	Single

**Pulverizers with Steam Generating Units other than Riley's.*



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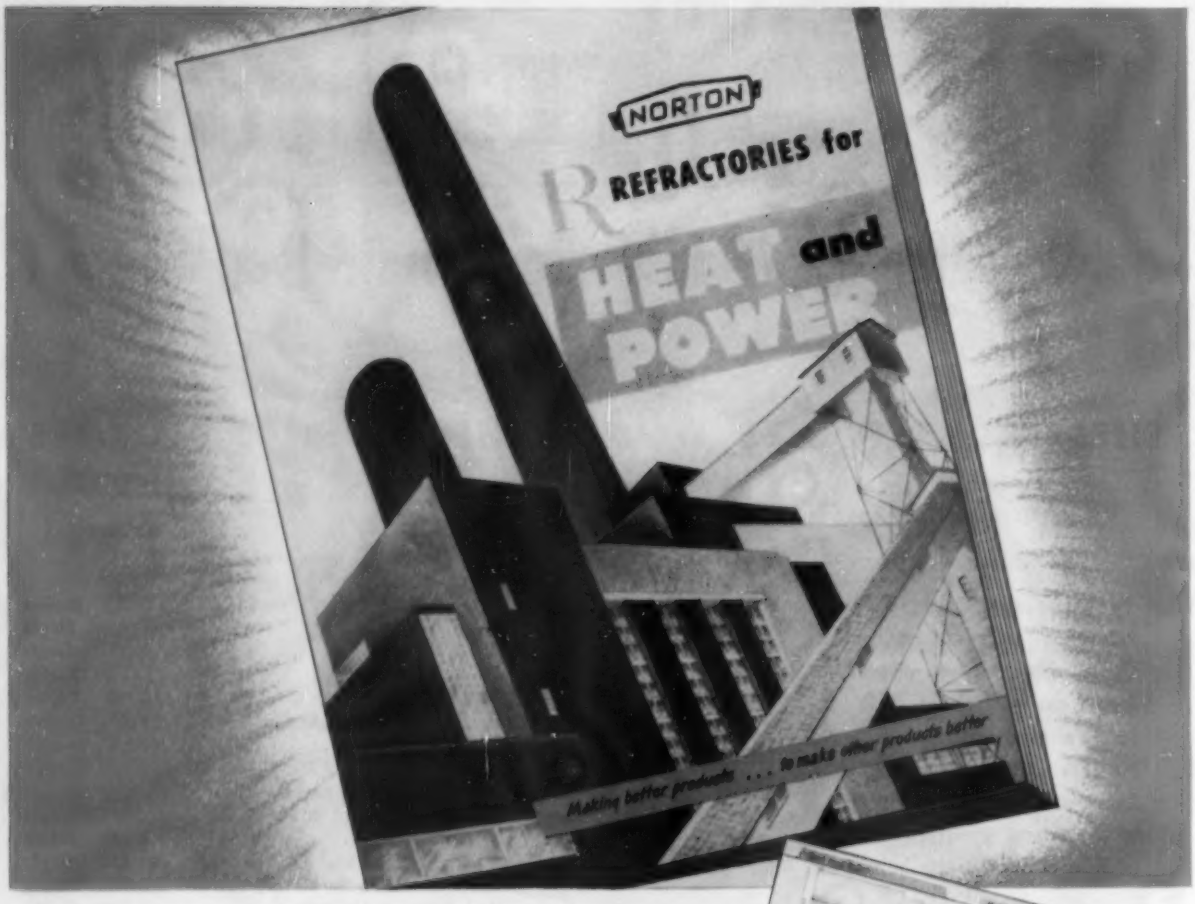

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Making better products . . . to make other products better

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Got an idea? It won't do you or the company any good unless you "sell" it. Start out by lining up the facts, then . . .

Write the boss a persuasive memo

► A MEMO from the management to you may not have to be persuasive. If the boss wants an idea adopted, he merely says so. Then somebody takes action. This holds, even in our free-enterprise system.

But when it's your idea, and you want the management to back it, that's a different story. The idea has to be sold.

The boss has other things on his mind. He's busy, pressed for time. A memo must catch his interest and make him realize the importance of the idea right away. In the first sentence, if possible.

Start out with a "hook." Put the fact that has greatest appeal at the beginning. Emphasize savings or other benefits. Be specific.

Steps in writing this type memo are: (1) Marshal the facts. (2) Decide which fact interests the boss most and put it in the first sentence. (3) Proceed to write in logical fashion as outlined on the next page.

Put in a "hook"

Going to write a memo? Here is 'bait' to sell ideas

Create interest

First: Know what a memo is

A memo is an informal letter. It's written to someone you know; most often to someone in your own plant or company.

It has the same general characteristics as a letter. Requires a notation as to who it's to and from, plus the date and subject. Salutation and complimentary close can be omitted if desired.

A memo, like any business letter, must be complete, yet brief as possible and clear in meaning. It should present only one subject and stick to that subject. For two ideas, write two memos.

Start with an introduction, but not a long one. Here's the place for the "hook" mentioned on previous page. But don't waste a lot of time in getting to the problem.

Decide on memo's purpose

This isn't as obvious as it sounds. A rambling start and fuzzy thinking have killed the effectiveness of many a memo. Know exactly what you want to accomplish before you start writing. Plan how to put the idea across. Be sure you have all the facts needed for a convincing story.

The boss is interested in costs and savings. Get this information. In capsule form, it's your starting "hook."

Following this brief introduction, a persuasive memo must state (1) the problem (2) the idea for solving it (3) the cost (4) the benefits (5) what action you want from the reader.

This general outline can be rearranged to suit specific cases.

State the problem

Stating the problem may or may not be difficult, depending on the problem. If it's complex, try to break it down into more easily understandable units. Make it clear that there *is* a problem, and that it's one the boss should be concerned with. Remember to write clearly, in terms he will understand. Don't be long-winded.

Present the solution

Next, give your idea for solving the problem. Present the broad outline, with essential steps involved. Don't give unnecessary details. Show the general picture as you see it. A persuasive memo supplies enough information for a decision on whether the idea is sound.

Keep a couple of alternative solutions up your sleeve, if possible. If the first scheme isn't acceptable, another may be.

Estimate the cost

Costs and savings always loom large in management's eyes. The budget may be the biggest single factor in deciding yes or no. So state what it will cost to carry out your idea. Get estimates from potential suppliers. Figure out how long it would take to remove existing equipment and install new apparatus. Find out what sort of delivery you can get.

Show the benefits

If adopting the proposal will save time, cut down on man-hours required for a job, reduce waste of materials, cut fuel consumption, improve morale, eliminate complaints about violations of smoke ordinances, etc, be sure to say so. Figure how soon savings will pay out the cost. This is highly important, should always be included if you can get the data.

Ask for specific action

The closing paragraph can be a short one asking the boss to approve the project, or take it up with other members of management, or discuss it further. Since you can't *tell* him what to do, be content to ask, or request, or suggest.

Write to get results

Your suggestion must seem reasonable. Try to make the boss *want* to comply with it. He must adopt the idea as his own, or the project will die an early death.

Keep a picture of the boss in mind while writing. State your idea simply in language he can understand. If he's not familiar with technical terms, don't use them.

Write to express the idea, not to impress your reader, as he knows you fairly well already. Don't grovel. Even a kindly man will have a hard time not stepping on an outstretched neck if it's put under his foot.

Have your memos typed. Good English is important but, even more important, keep the writing simple and clear. Use short sentences.

Suggest action

Now, let's work out an example

Suppose plant engineer Joe Dokes wants to meter steam supplied to various departments and charge for it on the basis of use. He believes this will cut steam waste, save money and reduce gripes from operating departments.

Supply throughout the plant is now "free." Anyone opening a valve gets steam. Nobody cares about peak loads on the boilers, nobody cares how much steam he uses. Everybody complains when pressure isn't up where it should be.

What Joe said	What's wrong with it	Joe might have said this
Subject: Metering steam	Pretty dull. Pep up the subject. Start with an idea slanted toward the boss.	**Subject:** How to cut steam waste with meters
The writer has noted for some time the fact that no effort is made to record quantities of steam used in the plant . . .	Get to the point. Throw in a "hook." What's most likely to interest the management?	**We can cut steam waste,** reduce gripes and save $— a year by installing meters in major steam lines.
Intensive investigation on the part of the writer and his staff, indicates that this problem in steam use is capable of solution should the management agree to take certain steps which the writer believes will be required . . .	Unless the boss is willing to wade through a long harangue of this sort, he may miss Joe's problem and recommendations altogether. And if he finds them, they won't be clear in his mind.	**Supply is now free** throughout the plant. There is no control on the amount any department uses, hence steam is wasted. Peak demands overload boilers, reduce supply pressure. This costs money and produces gripes.
In order to find a way to solve the problem, the writer investigated several sources of information, including . . .	Who cares? The point is, what solution does Joe think is best?	**Metering steam** supplied to the various departments and charging it on basis of use would cut this waste.
The necessary appropriation would not be considered exorbitant by the writer, inasmuch as $5000 was spent last year on revamping the lighting in Dept 16.	What has this to do with the cost of meters? It merely indicates that Dept 16 got an appropriation last year and Joe feels it's his turn now. He should stick to his own problem, be specific, give a cost estimate.	**Cost** of installing suitable meters in lines to each major steam-using department will be $———, broken down this way: (*If these figures take much space, put them on a separate sheet.*)
After the suggested proposal is carried out, people will be more careful using steam and we should save some money.	How much money? Give definite information to get action.	**Potential savings** would pay for the cost of the installation within a 3-year period. These savings are figured as follows:
. . .	Wait a minute! Didn't Joe forget something? How about asking for action? Memo won't serve its full purpose if it doesn't ask the reader to do something.	I hope you'll like this idea. Please let me know when we can go into it further.

SECOND OF A 2-PART ARTICLE By RICK DENNING, *Marine Engineer*

When your diesel acts up, use this check chart to...

Track down diesel headaches fast

SYMPTOM	POSSIBLE CAUSES OF TROUBLE
POOR COMPRESSION	1 Faulty valves (a) Improperly seated valves (b) Broken or weak valve springs (c) Sticking tappets (d) Insufficient tappet clearances (e) Warped or sticking valve stems (f) Valves burned, excessively carboned or pitted 2 Piston and rings (a) Worn or scored piston or rings (b) Broken or stuck piston rings (c) Piston-ring grooves worn 3 Excessively worn or scored cylinder 4 Leaky head gasket 5 Loose or warped cylinder head
EXCESSIVE CYLINDER AND RING WEAR	1 Abrasive material or water in fuel or lubricating oil 2 Use of corrosive fuel 3 Dirty air filter 4 Liner or ring material too soft 5 Improper lube-oil viscosity 6 Insufficient lubricating oil 7 Overheated engine 8 Stuck piston rings 9 Lack of lubrication on starting

SYMPTOM	POSSIBLE CAUSES OF TROUBLE
PISTON RINGS STICK	1 Poor grade of lubricating oil 2 Clogged oil-ring drain holes 3 Sediment or water in fuel 4 Dirty air filter 5 Sticking or warped valves 6 Carbon from poor combustion—see poor combustion 7 High piston-ring temperature—see overheating, first article 8 Weak or worn piston rings 9 Insufficient ring-groove clearance 10 Excessive piston-to-cylinder clearance 11 Worn or scored piston or cylinder liner 12 Distorted, overheated, misaligned piston or cylinder liner
HOT BEARINGS	1 Improper grade or insufficient lubrication 2 Dirty lube oil 3 Oil feed stopped up 4 High lube-oil temperature 5 Bearing or engine out of alignment 6 Distorted shaft 7 Bearings set up too tight 8 Uneven bearing or journal surface 9 Excessive bearing clearance 10 Overloading or overspeeding engine 11 Warped or cracked bearing, sprung bedplate

SYMPTOM	POSSIBLE CAUSES OF TROUBLE
FUEL KNOCKS	1 Too early injection—sharp knock 2 Too small clearance between fuel cams and rollers 3 Priming valve open 4 Spray-nozzle stem sticking open 5 Too much fuel being injected 6 Fuel injection too late—dull thud 7 Nozzle opening-pressure too low 8 Fuel-pump valve stuck open 9 Cold intake-air temperature 10 Air in fuel lines 11 Low ignition-quality fuel—use higher cetane number fuel 12 Heavy or viscous fuel 13 Fuel diluting lube oil 14 Rapid acceleration, overloaded, overheated 15 Leaky blower housing gasket 16 Leaky blower oil seal 17 Clogged air-box drains 18 Excessive engine speed 19 Compression pressure too low
MECHANICAL KNOCKS	1 Piston slap (muffled bell sound), excessive clearance between piston and cylinder wall, most audible at low speeds under load when cold 2 Piston-ring noise (click, snap or sharp rattle) on acceleration 3 Piston-pin noise (sharp metallic double knock) audible on idling hot engine (a) Excessive piston-pin clearance in piston boss or in bushing (b) Bushing loose in connecting rod (c) Connecting-rod end rubbing piston-pin boss 4 Valve and tappet noises (intermittent or continuous clicking noise) (a) Valve tappets out of adjustment (b) Valve stem guide or tappet worn (c) Valve sticking (d) Broken, weak or cocked valve spring (e) Stripped threads on adjusting screw 5 Bearing noise (a) Loose bearings—series of rapid distinct knocks on accelerating (b) Burned-out bearing — connecting-rod bearing knock heard at most speeds, main bearings at moderate speeds under load 6 Crankshaft knocks (a) Loose bearings, out-of-round journals (b) Excessive end play (c) Loose flywheel, crankshaft gear (d) Sprung crankshaft (e) Misaligned bearings 7 Uncommon engine noises (a) Weak spring in oil pump (b) Loose fan or belt (c) Loose engine accessories (d) Loose exhaust manifold (e) Timing gear loose or excessively worn (f) Leaky intake or exhaust-manifold gasket (g) Leaky cylinder-head gasket (h) Engine loose on bed (i) Piston sticking—violent knock each revolution
VIBRATION	1 Vibration transmitted from driven machine 2 Unequal cylinder compression 3 Misfiring on one or more cylinders 4 Bent or off-center coupling to load 5 Misalignment of engine to load 6 Engine loose on bed 7 Unbalanced or sprung crankshaft

SYMPTOM	POSSIBLE CAUSES OF TROUBLE
POOR COMBUSTION	1 Low compression pressure 2 Unequal cylinder loading 3 Insufficient or cold intake air 4 Jacket-water temperature too low 5 Frequent operation under light loads 6 Incorrect fuel timing 7 Weak nozzle spring 8 Low cetane fuel used 9 Sediment or water in fuel 10 High-carbon-residue fuel used 11 Leaky or sticking fuel nozzle 12 Fuel spray striking cylinder walls 13 Failure of fuel to atomize properly
CYLINDERS CARRY UNEQUAL LOADS	To get possible trouble cause: Check exhaust temperature and cylinder conditions. Then enter table below to pick out number corresponding to possible cause of trouble. Example: With "high compression" and "low exhaust temperature," item 13 shows (in numerical list below): "Head clearance too small."

Cylinder conditions	*Exhaust temperature*		
	High	*Normal*	*Low*
High compression	—	1	13
Normal compression	2	1	14
Low compression	3	8, 9, 10	15 to 19
High firing press.	4	11, 12	20, 21
Normal firing press.	2, 5	1	14
Low firing press.	6, 7	8	22

1 Normal operation
2 Cylinder overloaded
3 Leaky valves (intake and exhaust)
4 Excessive fuel injection
(a) Fuel rack too far in
(b) Fuel-valve lift excessive
(c) Nozzle-tip opening too large
(d) Nozzle opening pressure set too low
(e) Leaky fuel nozzle
5 High exhaust backpressure
6 Exhaust valve clearance (lift) too small
7 Fuel timing too late
8 Air breather clogged
9 High altitude
10 Insufficient blower air delivery
11 Dirty fuel oil
12 Low-cetane fuel oil
13 Head clearance too small
(a) Connecting-rod shim too thick
(b) Cylinder gasket too thin
14 Light load
15 Head clearance too large
(a) Connecting-rod shim too thin
(b) Cylinder gasket too thick
(c) Bearing clearance excessive
16 Leaky head gasket
17 Loose or warped cylinder head
18 Stuck or worn piston rings
19 Worn cylinder liners
20 Fuel timing too early
21 Water in cylinder
22 Insufficient fuel injection
(a) Fuel rack too far out
(b) Clogged nozzle spray holes
(c) Fuel-valve lift too small
(d) Nozzle opening pressure set too high
(e) Leaky fuel line gasket or connection
(f) Worn fuel cams

ENTRIES NOW OPEN FOR 1955 AWARDS

To find out how to tell us about your modernization job, see p 81

LOOSENING DEPOSITS of grease and dirt from guide vanes in ductwork. Most cleaning isn't nearly as accessible as this

VACUUM CLEANER is removing loose dirt. Suction cleaning method takes up the dirt so it won't be blown out on starting

It pays to have professionals clean your air-conditioning system

Your own men could clean ducts, fans, etc, but chances are they haven't the experience to do an efficient job. Besides, proper equipment is too expensive for the use it would get

► CLEANING an air-conditioning or a kitchen-exhaust system can be a nasty job. To do good work that will last a while, you need equipment and you need experience.

Proper equipment involves an unwarranted expense for a private owner who might use it at most twice a year. And when you take a couple of men off the regular force to do the cleaning job, not only do you lose their services for a few weeks, but you also get a poorer job because of their inexperience.

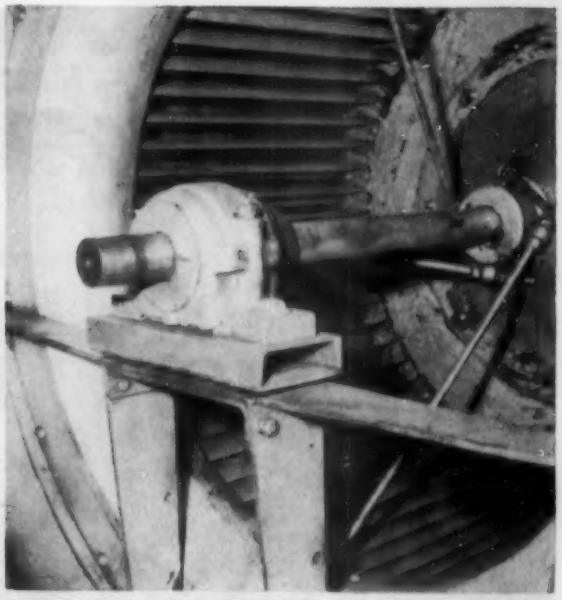
Chances are your men wouldn't particularly enjoy the job either—they may well say they were not hired to do this dirty work. Too, they probably would not be up on safety precautions involved. So there would be the risk of a flash fire or of fumes overcoming one of the men while in the ductwork. Flash fires in hotel ducts have proven deadly in the past. And the men must know how to protect themselves and each other while on the job.

The answer to this problem need not be difficult. Why not hire outside help? Make a contract with some outfit whose business it is to clean air-conditioning and exhaust systems. The men working for such a company are hired and paid to do this dirty work. They have the experience and know the safety precautions—after all, it's their job. And they have the equipment to do the cleaning properly.

There *are* such companies. We heard about one in the New York area, and naturally we wanted to learn more about its operations. So we talked to Philip Berlin, president of the Power Cleaning Corp of Brooklyn, N. Y. His outfit specializes in cleaning air-conditioning systems and kitchen exhausts.

Equipment used by his men on cleaning jobs ranges from an electric boiler for steam lancing on tough jobs to industrial vacuum-cleaning gear. The big bonus lies in the fact that they know what to do and how to do it.

PAINTING SURFACES with aluminum paint after cleaning keeps dust from sticking to the ducts and blowers, makes job last



BLOWER SURFACES partly cleaned to make ready for painting. Kitchen exhaust system gets the same kind of treatment.

Typical of the conditions a suction-cleaning company may run into are those of two hotels. In one hotel, two men were taken from the service gang to do the cleaning twice a year. The men lacked suction equipment and know-how, and the results were not good. After the cleaning was completed and air conditioning turned back on, dirt and soot came out of the ducts and got on food in one of the dining rooms.

In the other hotel, there was a 28-year problem of soot and dirt on dining-room tables near registers. In both hotels, cleaning the ducts with vacuum equipment stopped soot and dirt problems.

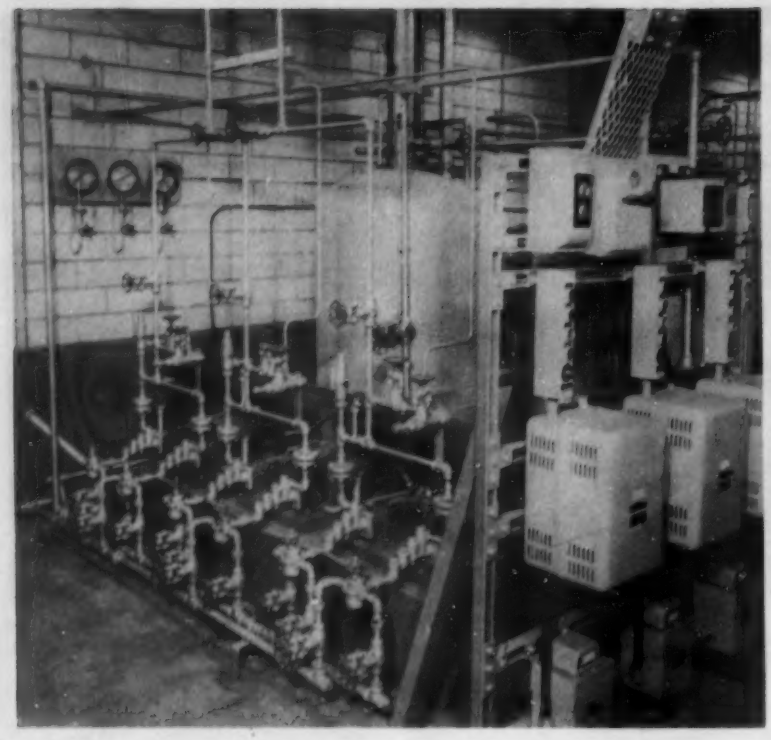
Another cleaning job by a suction-cleaning outfit shows what a wide range such a company can cover. In a large steel mill, the management found that job of cleaning up dust and steel shavings in the mill was much too expensive when they had to use their own men to do it. They found it was cheaper to call in the experienced cleaning company. Suction cleaning did the job with a minimum of dirt falling on work spaces.

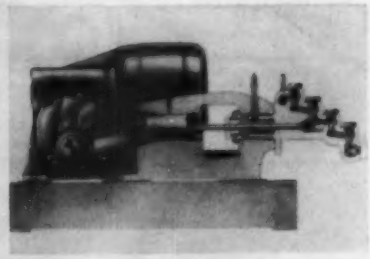
After getting a little of the background, we felt we would like to get a few photos showing this suction-cleaning system operating. So we went to a couple of Hilton Hotels, and with Philip Berlin's help and the cooperation of Tom Barrett, the superintendent of the Waldorf-Astoria Hotel, and Bill Darlington, superintendent of the Roosevelt Hotel, we got a look at some actual cleaning jobs in progress. Photos above show some of the different steps.

Loosening deposits in the ductwork may amount to just using a scraper and a little elbow grease. In very stubborn cases, where deposits have hardened on the surfaces, it may be necessary to bring in the electric boiler to loosen them with a steam lance. Once dislodged, the debris is removed principally by the industrial vacuum cleaner. Less stubborn deposits are removed directly with suction. After thorough cleaning, the surfaces are given a coating of a quick-drying primer and then a special grease-resistant non-combustible aluminum paint. The paint is sprayed as far down the duct as possible. Its purpose is to keep particles from sticking to the surface so the job will last longer.

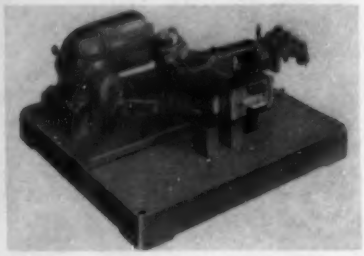
No. 12 of the Bill Eddy cartoons

"Scram, Junior, we'll work this out our way!"





1 Standard motor-driven simplex controlled-volume pump has a constant-speed drive. Stroke length can be adjusted by screw to give variations in capacity. This adjustment, made while pump is stopped, alters the trunnion position



5 Completely automatic adjustment of stroke length is also available in motor-driven units. Small reversing motor activates adjusting mechanism; limit switches and a control potentiometer mounted in the pump base are also a part of the controls

Controlled-volume pumps, one modern answer to...

Solving low-capacity flow-control

By G E SHAFFER Jr. *Registered Engineer, Milton Roy Company*

► CONTROLLED-VOLUME PUMPS, also called proportioning, variable-displacement, variable-stroke, metering, and by other descriptive names, are often thought of as only water-treating devices. This is misleading since these units are widely used for many low-capacity flow-control jobs.

Even the word pump is somewhat incorrect because these units are more than mechanical devices to circulate or transfer liquids. They are flow-control instruments.

Designs. Most controlled-volume pumps are reciprocating-plunger positive-displacement type units, designed to accurately deliver a metered quantity of liquid or slurry to a point of application.

Basically, these pumps consist of a drive unit, plunger and a displacement chamber or liquid end, in which the plunger reciprocates, Fig. 1.

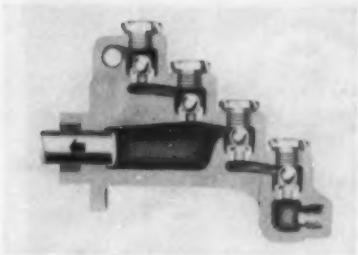
Plunger diameter and stroke length determine dimensions of the displaced liquid volume. The larger the plunger diameter, the greater the amount of liquid discharged for the same stroke length. Likewise, a long stroke length delivers more liquid than a short. For a given diameter and stroke, volume of liquid delivered over any given period is directly proportional to pump stroking speed. Metering accuracy is within 1%.

Discharge pressure against which these pumps operate has little effect on pump capacity, except at extremely high pressures when liquid's compressibility must be considered in analyzing the job.

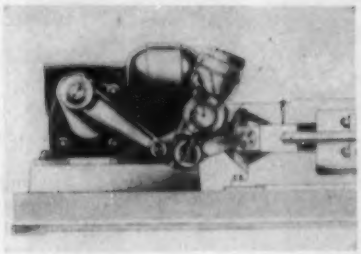
Control. Choice of control is fixed by nature of the application. Since a large number of different controls may be used with these pumps, they are extremely flexible in application.

Manual control, Fig. 1, 3 and 4, is available in a number of forms to adjust stroke length.

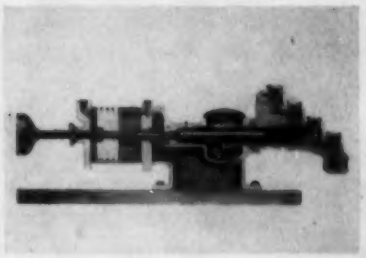
Completely automatic adjustment of stroke length, Fig. 5, is available for motor-driven pumps. This type is used as a final control element of a process variable, such as pH. In an installation of this kind, Fig. 9, the bridge-circuit pH controller measures the process variable. The motorized-stroke-adjustment pump regulates control-agent flow to process. Any deviation from process



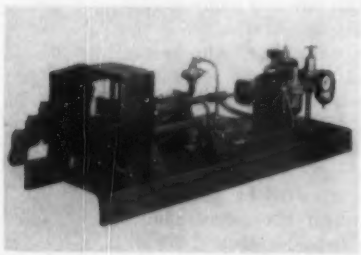
2 Suction stroke of plunger creates partial vacuum permitting the inlet ball-check valves to rise, as shown. While the inlet valves are open, liquid flows into and fills displacement chamber. During suction, outlet valves are closed tight



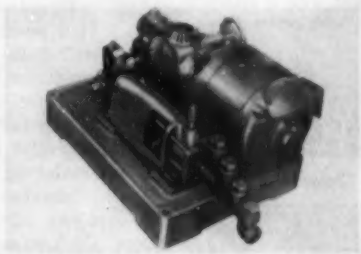
3 Motor-driven pump with dial adjustment of plunger stroke length. This design is used where adjustment must be made while pump operates. A handwheel operating over a chain through a gear train in the rocker box provides adjustment



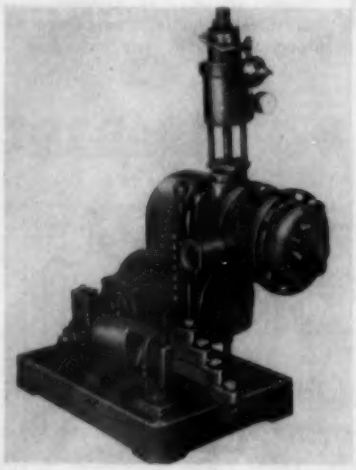
4 Air-powered pump has a simple manual stroke-length adjustment. Reciprocating air piston is directly coupled to the pump plunger. Vernier-screw adjusts stroke length, limiting return stroke of piston in the air cylinder of the pump



6 Piston operator with positioner, which sets limit of stroke length in response to an instrument-air signal, is used in this air-powered pump to give automatic adjustment of plunger stroke length. Valve on end of piston releases air to limit stroke

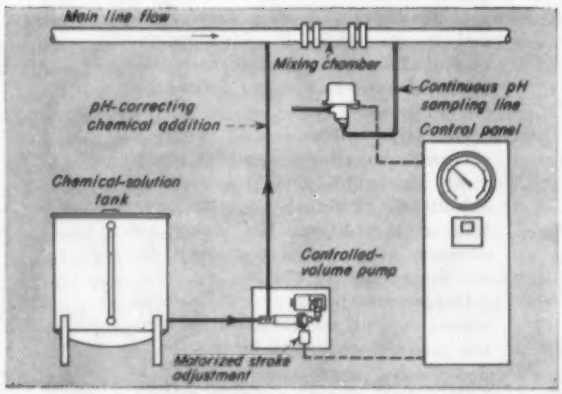


7 Mechanically adjustable speed-changing mechanism permits manual pump-speed regulation. With it, pump-plunger stroking speed is infinitely variable, while pump runs or is at rest, over speed ranges of 2 to 1 to 15 to 1; capacity range: 150 to 1

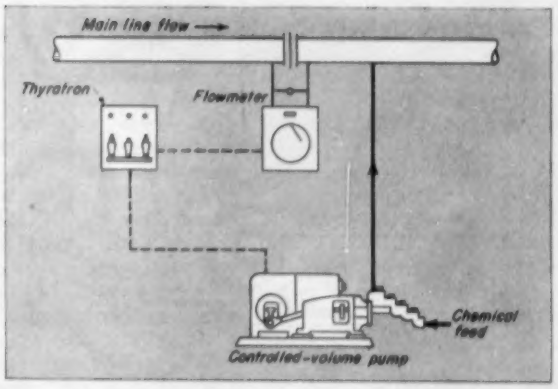


8 Automatic control of pumping speed is obtained with this pneumatic controller by using variable-speed mechanism on the pump, as here. Air signal from controller varies pump stroking speed to increase or decrease amount of control agent

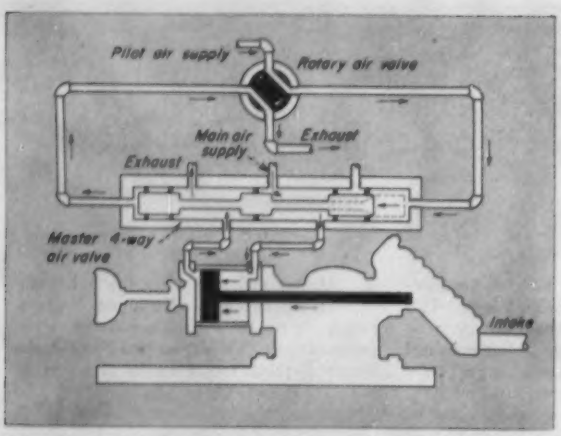
problems in power plants



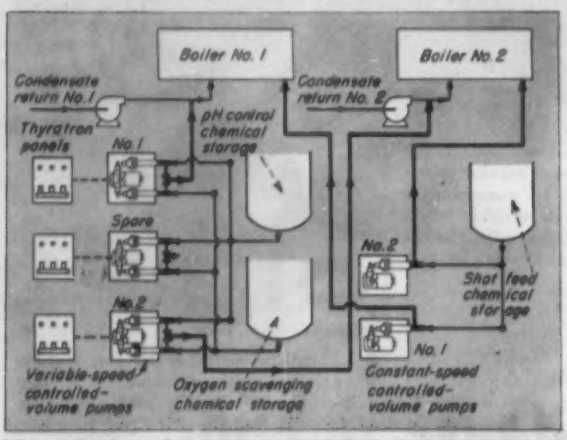
9 Pump with completely automatic adjustment of stroke length used as final control element of a process variable—in this case pH. Main-line flow rate constant



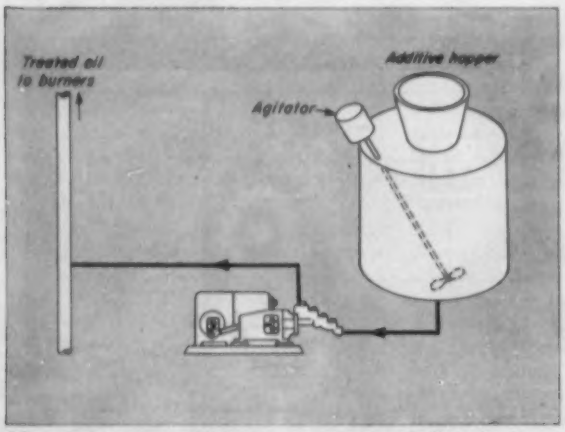
10 Electronic control system for positive automatic speed regulation uses a thyratron rectifier unit, holds plunger speed constant regardless of plant load change



11 Suction stroke of an air-driven pump fitted with a rotary air valve to control pump speed directly with water flow rate through a meter in main water line



12 Controlled-volume pumps used in the boiler-water treatment system in large utility. Thyratron control permits variation of pump speed to change the dosage



13 Constant-rate additive-injection system handles alumina or dolomite slurry. A 1:1 additive-to-ash ratio produced ash with higher fusing point in a utility

set point results in automatic adjustment of pump stroke length to increase or decrease control-agent flow, as needed.

Stroking speed. Since pump capacity is directly proportional to speed, positive speed regulation gives direct control of the exact volume delivered. Any one of several speed-changing mechanisms, manual or automatic, can be used in motor-driven or air-operated pumps.

Fig. 7 shows a typical manual speed regulator, while Fig. 10 shows an automatic proportional feed system. Fig. 8 uses automatic pneumatic control.

To pace the air-powered pump in Fig. 11 a positive-displacement meter is installed in the water line, with meter integrator head replaced by the rotary air valve shown. Meter shaft and air valve rotate in direct proportion to flow. Air valve sends out two impulses per revolution.

Impulses are received by the master 4-way valve, which alternately admits air from one side to the other of the air cylinder, operating the pump. This controls the pump speed directly with the water flow rate through the meter. Adjustment of stroke length varies ratio of additive to water stream.

For large process lines, orifice or venturi meters are easily adapted to send out electrical contacts for pacing pump.

Pumps are available for use as the final control element in any instrumented system. Whenever the flow rate is small or pressure drop across the control valve varies, a pump designed for this service insures accurate repetitive control over any process variable.

Power-plant applications for reciprocating - plunger positive - displacement pumps of this type include (1) metering and pumping of predetermined small quantities of chemicals and slurries (2) accurate ratioing of two or more chemical streams and (3) precise automatic control of a process variable, especially in the ranges where valves do not normally operate.

One large utility uses 33 pumps to service its boilers and auxiliary equipment. The pumps, photo, p 120, run intermittently to care for specific problems as they arise. The higher the efficiency of the major equipment, the less the pumps are used.

Oxygen scavenging, residual calcium removal and pH control are a few common power-plant services for these units. Sequestering agents, added directly to boiler drum, remove residual calcium and prevent scale formation. An agent pump is used for each boiler. The flow

(*Continued on page* 210)

Coal conveyor...

power scraper...

instrumentation

Many jobs for multipurpose grease

By T A McCONNELL, *Senior Engineer, Engineering Laboratory and Research Dept, Detroit Edison Company*

► LATE IN 1951, we started out at Detroit Edison Co to find one or two multipurpose greases to replace the many greases in the company's power plants. After some three years, we have trimmed back to two greases: Both are lithium based and one is an extreme-pressure lubricant. The first step was taken when a multipurpose lubricant replaced grease in the coal-conveying system at Conners Creek power plant.

Why? There's little new in the reasons for multipurpose lubes. Both central-station and industrial plants have leaned in this direction for years to reap the benefits of simplified purchasing, storage, inventory, besides more effective lubrication.

Several greases, available today, fall into the multipurpose category. However, the grease we selected for this many-purpose role uses lithium 12-hydroxy stearate as the soap. Our tests indicate it possesses all the necessary properties. It has the high melting point of soda-soap grease, water resistance of calcium-base grease, plus good pumpability at low temperatures. The latter is of major importance in centralized lube systems exposed to low temperatures.

Starting point for the program was the Conners Creek plant. Here the coal conveyor was originally supplied with a soda-lime grease. Complete conveyor system has some 6300 idlers each requiring grease. And since some 60% of the system was outdoors, ambient temperatures down to −10 F could be expected in addition to dust and moisture. By taking 40 idlers at a time, the complete conveyor system was gradually swung over to the lithium-base grease. Schedule now calls for yearly gun lubrication of all bearings—one shot per idler.

One direct benefit of multipurpose grease is noted during cold weather. It had been standard practice, with the old grease, to run the conveyor belt unloaded about 15 minutes when starting up on cold days. Now, regardless of weather, this run-in precaution is eliminated.

Progress was made by converting other plants in the system to lithium. Conners Creek originally required 9 greases, now they're down to 1; Delray and Trenton Channel started with 5 and whittled down to 2. Likewise, Marysville needed 11 some time back and now find the 1 lithium grease ample. Although the production department in each plant is the heaviest grease consumer, the central heating, underground lines, meter, substation, and motor transportation departments are following suit.

Change-over plan often came in the wake of a lubrication problem. Example: At Conners Creek, grease channeling in rolling-contact bearings of temperature recorders was severe. The multipurpose grease came into the picture and after a year in operation, at a high ambient temperature, no signs of channeling were noted. Gradually, the lithium grease was adopted for applications in the meter department.

Extreme-pressure-type grease, having the same base, is used where need exists for an e-p lubricant. One application is in the plant's automatic lubricators that feed equipment operating at high bearing loads.

E-p lubricant is a dark amber grease having a texture, soap content, dropping point and ASTM consistency similar to the general-purpose lithium lube. However, it handles a 43-lb minimum on the Timken test.

Other applications for the multipurpose grease include some 2500 motors, also bulldozers, cranes and mobile yard equipment. Motor transportation department specified lubricating shackles, wheel bearings, chassis and steering mechanisms on some of the company's trucks with the multipurpose e-p grease. Trucks operate in tough weather and are exposed to salt spray. Present grease program is being extended to eventually include all the company's passenger cars plus other automotive equipment.

Although each of the five Detroit Edison plants is responsible for its own lubrication maintenance program, all find the swing to multipurpose grease offers real savings.

OPERATORS' NOTEBOOK 83

Now we'll inspect external

1 Safety valve is most important fitting on boiler. Examine spring to see that no foreign material is wedged between coils. Check the general outside condition

2 Valve lever must be in working order; but don't lift valve on dead boiler

6 If stop valve is in water column, install the outside screw-and-yoke type

7 Globe valve must be between drum and check valve, pressure under seat

8 Main stop must work freely. No leak around packing gland or insulation

11 Asbestos rope between the sinuous headers must be tight; no air leaks

12 Blowdown valve and fittings must be shipshape: can shut down boiler

Inspection Code is

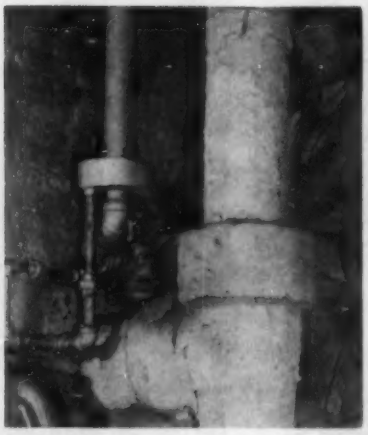
► WE INSPECTED boiler waterside and fireside—Notebooks 79 and 81: Oct, p 122; Dec, p 128. National Board Inspection Code requires registered power boiler to be inspected at regular intervals. Now let's wind up this job by inspecting the external fittings with Inspector Ed Zeman, of Hartford Boiler Inspection and Insurance Co.

Safety valves are the most important attachments on boiler (see Notebooks 74, 80 and 82 for overhauling safety valves). There should be no rust, scale or foreign matter in casings to hinder free operation. Best way to test setting and freedom of safety valves is by pop-

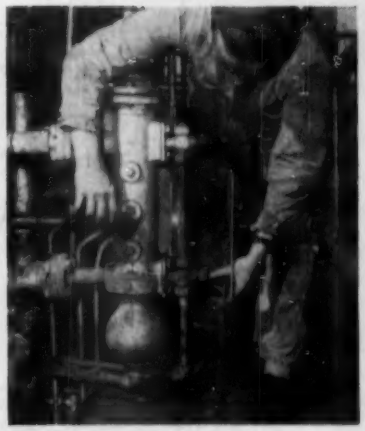
fittings of your boiler: 3

By STEVE ELONKA
Associate Editor

3 Escape pipe has to be well-bracketed; drain hole clear to carry condensate



4 Superheater safety must blow first to keep flow through the superheater



5 Gage-glass shut-off valves should not bind or leak. Check condition

9 U bolts through channel-iron supports help hold weight of steam drum. Examine bolt threads and everything connected with support to insure first-class order

10 Soot blowers may not work or they may be ready to fail. Inspect well

very firm on these twelve important points—you must know them

ping valves with steam. If this can't be done, test by try-levers. Inspect discharge pipe to make sure it's secure, won't blow away when valve pops. Operators have been killed as valve discharging into fire room fills space with steam in few seconds. Drain-opening in discharge line must not be plugged.

Steam gages have to be removed to test by comparing with a standard test gage. Steam gage must not be located so it's exposed to externally high temperature or to internal heat. Blow out steam pipe leading to steam gage.

Water column. Steam pipe should drain toward column, water-pipe connection should drain toward boiler so water cannot accumulate in steam connection, giving false reading.

Observe relative position of water column to fire surfaces of boiler for conforming to Code requirements for your boiler. Examine condition of attachments.

Suspended boilers. Examine supports where boiler structure comes near setting walls or floor. Make sure ash and soot won't bind boiler structure to produce excessive strains from expansion under operating conditions.

Check-valve and stop-valve in feedwater inlet line must be placed so stop valve is next to drum, with pressure under seat of globe valve.

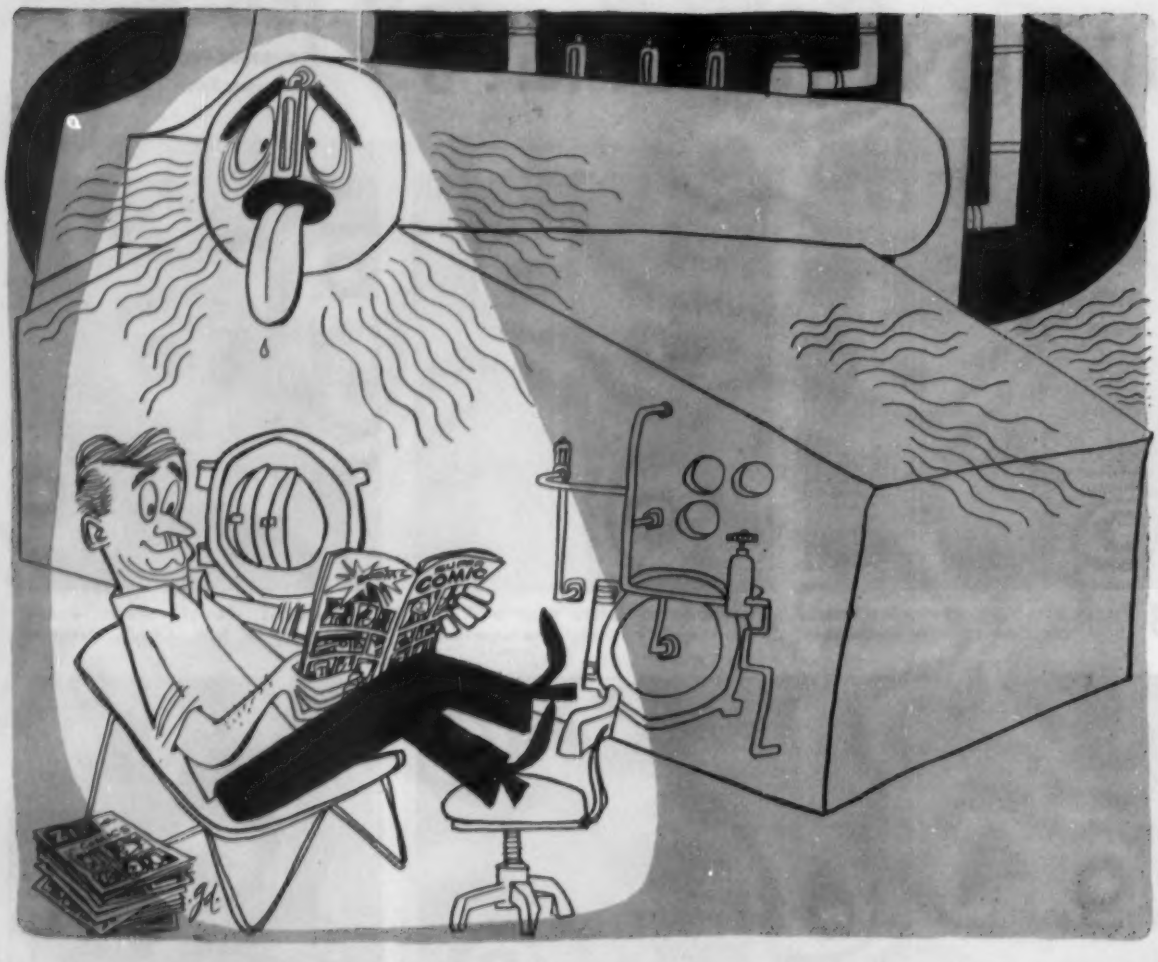
Main stop must be in working condition, check externally.

Soot blowers need checking for doing their job right. They can cut tubes.

Sinuous headers must be calked or air leaks into the boiler between headers and cools it, raising excess air.

Blowdown valves must work freely, be packed, and all external piping and fittings be inspected to make sure they are not corroded or otherwise damaged.

Study National Board Inspection Code and avoid outage and accidents by keeping your boiler safe—and efficient.



Low water level causes most trouble. Here's how...

You can prevent boiler accidents

By HARRY M SPRING, *Professional Engineer*

► A BOILER ACCIDENT doesn't just happen. Most of the time the cause is found in the operating procedure or in ignored safety precautions. You can prevent accidents by taking proper care during all phases of operation.

Normal operation. Low water damages more boilers than any other cause. As an operator, keep wide-awake at all times and watch the water glass carefully.

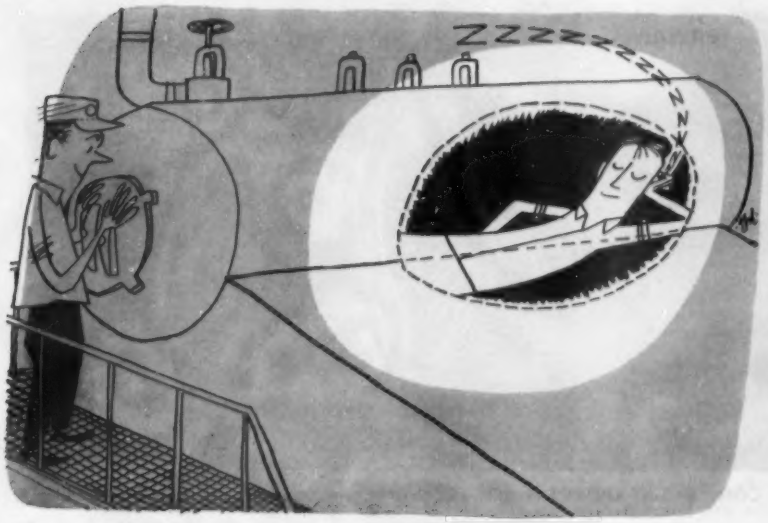
In taking over a shift, check all appliances and examine the boiler carefully for any abnormal condition. Do this before the preceding operator leaves. Also question him about anything out of the ordinary.

Keep a log showing all conditions periodically. This is a requirement in some states. Knowing what has gone on before helps you analyze an unusual situation.

Boiler plant cleanliness gives better working conditions and cuts down rapid wear of equipment. Dirty or worn equipment causes accidents. An air hose may seem to provide an easy way to clean up, but usually all it does is redistribute the dirt. And its use can be dangerous. Never permit anyone to point an air hose at a person or to use it in horseplay. This has proved fatal.

Know your safety valves, their purpose and how they work. If one pops at other than the set pressure, do not tamper with it. Blow out the gage line and check the gage with one of known accuracy. If its operation is satisfactory, a slight change in safety-valve-adjustment under proper supervision may be necessary. If valve needs a considerable change, something is radically wrong. The valve should be checked thoroughly before making any changes.

Operate soot blowers regularly. Do



Check inside of boiler before closing

it periodically—preferably on the basis of flue-gas temperature. Use soot blowers when flue-gas temperature has risen a set amount. When using soot blowers, drain condensate from them before opening valve to element.

Starting up. Before closing a boiler, make sure no one is in it and all tools, debris, oil and other foreign material have been removed. See that gasket surfaces are clean and smooth. If using asbestos gaskets, it is a good plan to paint them with a mixture of 600-W cylinder oil and graphite.

When filling boiler, use warm water if possible. Vent the unit at highest point to exhaust all air. Check position of all valves carefully. See that blowdown valves are closed and vent valves open. Close stop valves on steam lines.

Before firing boiler, apply hydrostatic test at pressure slightly below safety-valve setting and check all riveted joints, welded seams and tube ends for leaks. If you find a leak, trace down its source and make approved repairs before firing boiler.

After lighting fires, allow enough time in building up pressure. Large boilers may require eight or more hours to avoid overstressing due to rapid expansion. While boiler is coming up to pressure, observe all parts carefully for leaks or any abnormal condition.

Put boiler on line when pressure is two or three pounds below line pressure. This way, any condensate trapped between the stop valves goes back to the boiler rather than in the steam main where it might cause water hammer and bursting of piping. First, open the outside stop valve very slowly until it is wide open. Next, open drain between stop valves until dry steam blows through. Then, close drain and open inside stop valve very slowly.

Abnormal conditions. Open feed valve wide immediately when water gets low in boiler. If nothing is done to the feed valve, the water gets lower before heat of fire and brickwork can be reduced to safe value. Numerous experiments and experiences show that an explosion is not caused by suddenly putting water into a hot boiler. If boiler is cast iron or has cast-iron headers, though, cracking may result in the cast iron.

One experience may be of interest. A 2-inch feed valve was opened suddenly, supplying water to a boiler whose drum had been heated red hot. A pressure-recording chart showed that the flash of steam from the incoming water caused a rise in boiler pressure from 150 to 155 psig. Hardly likely to cause an explosion. In fact, here the water undoubtedly prevented an explosion.

Next thing to do in case of low water is to kill the fire as quickly as possible. Smother it with green coal or ashes for a hand-fired boiler. Leave firing doors open, and open the damper wide. For stoker-fired boiler, use fire hose and cut off coal feed and all draft fans. Open all access doors to admit cool air. Just trip burners and draft fans for pulverized coal, oil or gas firing, and again open all access doors to admit air.

For high water, open blowdown valve to reduce level to normal limits. Be sure water is actually high—not low and out of sight of the glass. Quickly opening and closing the gage-glass drain and watching glass acts as a double check of the level. If trycocks are installed, use them. Never open blowdown valve and walk off and leave it. If it is necessary to go around to the front to see the gage glass, hold valve open for 10 or 15 seconds, then close it before going to check level in glass.

If steam pressure can't be held up, something is wrong. Possibly internal scale cuts down heat-transfer rate. Opening the boiler will answer this one. A broken steam line in some part of the plant may be the cause. In one plant this happened—the night fireman nearly exhausted himself for three hours trying to keep up steam pressure while one portion of the factory filled with steam with very expensive results.

Look over all boiler parts frequently for leaks. If you find a leak, trace it to its source. Steam drum or shell-plate leakage is usually serious. In such case, take the boiler out of service immediately for inspection.

If flame goes out in pulverized coal, oil or gas burner, hold maximum draft for several minutes before relighting. Otherwise, a dangerous furnace explosion may result.

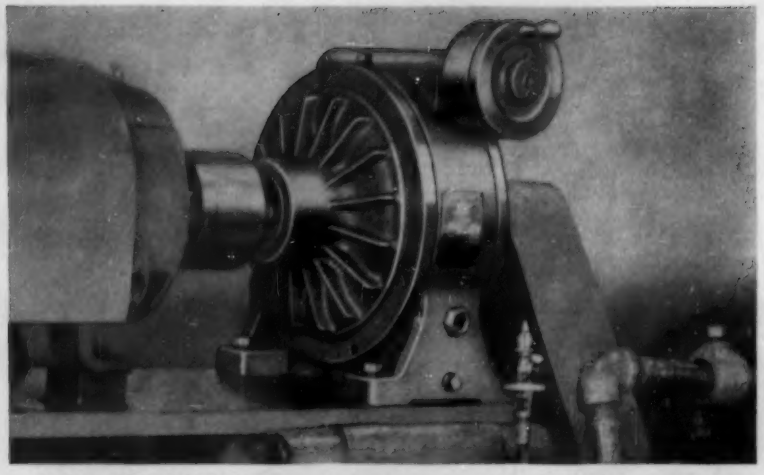
Look for cause of boiler vibration before it causes costly damage to boiler or setting. When burning fuels in suspension, lack of air in the boiler room due to tightly closed windows is a possible cause. Defective burner adjustment or deficient primary-air supply can also cause vibration. Make sure prime mover is not transmitting vibrations back to boiler through steam piping.

Keep your plant clean

Shutting down. Allow fuel beds to burn down thoroughly before taking boiler off the line. This prevents excessive blowing of safety valves.

(Continued on page 218)

DRIVING PARTS include disks and balls



CONSTANT-HP OUTPUT permits unit to drive machine tools like this thread miller

New twist on friction drives:

Changing axis varies output speed

► THE PRINCIPLE of friction drive is now applied to an infinitely variable-speed unit. Frequently used during the last century, this principle of power transmission has recently been revived in Germany on constant-speed drives up to 100 hp (see "Today's friction drives are reaching for 150 hp," Feb 1954, POWER).

This variable-speed application transmits power through a series of 4 to 8 driving balls, with operating efficiency of 75 to 90%, maker states. Input speed and horsepower determine number of balls and size of unit. At present, sizes range up to 10-hp input at 1750 rpm.

Constant-hp output. Transmission provides constant-horsepower output and is suitable for driving any machine requiring this characteristic. Photo, right, shows a 3-hp unit installed on a thread milling machine. It replaces the change gears originally supplied with the miller, giving the operator closer control over the cutter speed.

Unit is based on a design patented by Swiss engineer Jean E Kopp. The drive has been manufactured for several years in various European countries, including England, France, Belgium, Germany and Switzerland, where it has proved practical and efficient. It was redesigned for manufacture in the U.S.

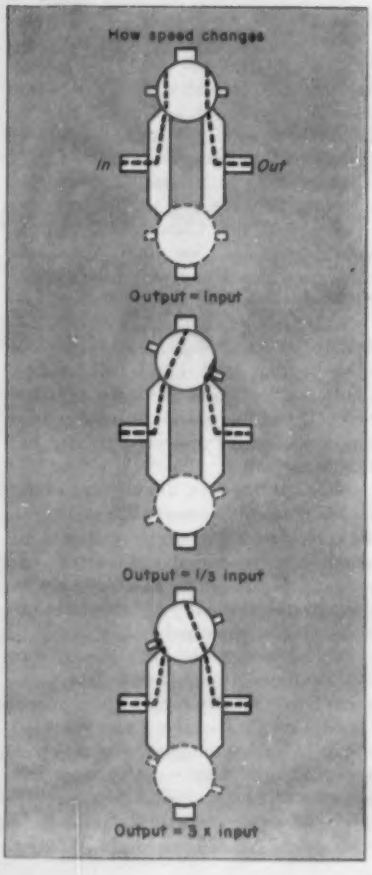
The transmission provides infinitely variable-speed output over a 9:1 range, from one third to three times the constant input speed. Changes in speed are made only when transmission is running.

Operating principle. Schematic drawings, right, show the operating principle. Power input is transmitted through a disk to the driving balls, which turn on axles. Radial force imposed on the driving balls is countered by a free-floating ring enveloping them. Pressure between the balls and the corresponding disk on the output side transmits power to the output shaft, which turns in the same direction as the input shaft. Turning the worm-and-gear arrangement changes the angular position of the ball axles, adjusts relative shaft speeds.

With ball axles parallel to axis of the shafts, ratio is 1:1. Tilting axles toward input shaft increases output speed; tilting toward output shaft decreases output speed. The balls themselves are not restrained radially by their axles; the three points of contact provided by the outer ring and the two driving disks keep them in place.

Large changes in applied torque produce a slight shift in the positioning of these free-floating components, which in turn produce small inherent speed changes. Over the full range of rated torque, speed change is about 4%. Under constant torque, however, there is no tendency to drift and constant-output speed can be maintained.

Courtesy: Cleveland Worm and Gear Co



Silent chain Q&A

Q Where do you use silent chain?

A Silent chain can transmit from a fraction of one to over a thousand horsepower. You can run it up to 5000 fpm, but best working speeds are between 1400 and 3500 fpm. Below 1200 fpm, roller chain may be better. Speed ratios up to 12 to 1 are possible, but it's best to stay below 8:1.

Silent chain is quieter than roller chain, but not as quiet as V belts. In larger horsepower brackets, it takes up less space than a corresponding belt drive. You can be sure of constant velocity ratio between driving and driven shafts when using silent chain, but it will not absorb shock.

Q Is it standardized?

A On November 9, 1950, the American Standards Association approved a recommendation for standardizing silent-chain drives, primarily on the basis of sprocket tooth design (ASA bulletin B29.2-1950). Since individual manufacturers use various chain-joint designs, standards on the chain merely insure interchangeability.

Standard sprockets use a 60-deg angle with a tangency circle of .75 times pitch. Contours of the links may vary, but they must engage standard sprocket teeth so joint centers lie on sprocket pitch-diameter. Chains under ¾ in. wide use side guide; those ¾ in. and over use center guide, according to the standard.

Chain is designated by the two letters SC as a prefix, one or two numerals indicating pitch in eighths of inches, and two or three numerals indicating the width in quarter inches. Widths exceeding 16 times the pitch are not recommended.

The ASA standards are advisory only. Their use by anyone in the industry is entirely voluntary. To be sure your drive is interchangeable with other manufacturers' chain and sprockets, check whether it is ASA standard before you buy.

Q What maintenance does it require?

A Any chain drive needs periodic inspection to insure proper operation. Be sure shafts and sprockets are carefully aligned before starting, and check on chain tension. Normally, horizontal and inclined drives should have an initial sag about 2% of distance between shaft centers. Here is a suggested maintenance routine:

Inspect new installation after 100 hours of operation, again after 500 hours, and periodically after that.

Check sprocket alignment and see if chain or sprocket teeth are worn. If badly worn, replace. Retighten set screws if necessary. Take up any accumulated slack and provide proper tension.

Change the lubricant after the first 500 hours of operation; subsequently, change after each 2500 hours running time. Clean out the casing and chain if you find contamination.

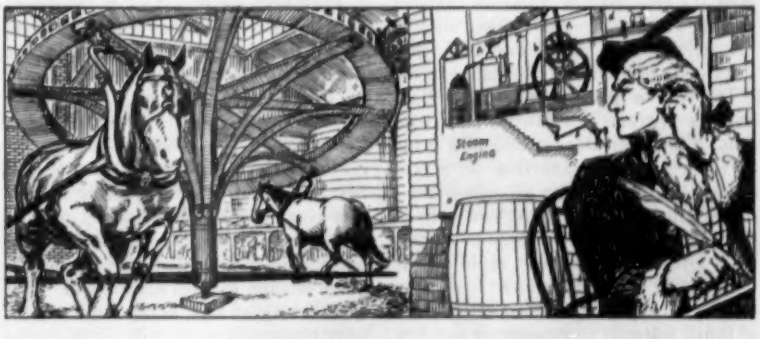
Q What's the best lubricant?

A Select lubricant on recommendation of equipment manufacturer and oil supplier. With viscosity-index improvement built into modern oils, you can go wrong in selecting an oil on the basis of viscosity alone.

Q What type of lubrication system is best?

A You have to consider chain speed, relative shaft positions and the type of atmosphere surrounding the drive. Use manual or drip-cup lubrication only for small horsepower drives running slower than about 1500 fpm. Be sure there is no abrasive dust in the atmosphere. Use splash, oil-disk or forced lubrication for enclosed drives. Forced system is best for large horsepower, heavily loaded, or high-speed drives, or where splash or disk systems cannot be used.

Average horse's output less than a horsepower



► IN THESE DAYS of atomic power and superpressure steam, it does no harm to look back occasionally. To 1784, for instance; in London, England.

Robert Barclay, owner of the Anchor Brewery, had Messrs Boulton and Watt install a steam engine. This was the first engine in his brewery, and undoubtedly the first on the site. Before the brewery was erected, the old Globe Playhouse had occupied the spot.

As far as we can tell, Boulton and Watt gave the job of erecting the engine to their employe William Murdock.

Barclay wanted to know how much power the engine would develop. Scholars believe that Murdock then deduced the value of the standard horsepower.

This calculation is commonly attributed to James Watt, and it may be that Murdock acted under Watt's instruction in his investigation. Anyway, he compared engine output with the performance of horses.

He observed horses moving around a circular track, driving a pump that raised water from a well. Some old drawings at the brewery clearly show position of the "horse wheel."

By comparing the work of raising water with the energy spent by the horses, Murdock discovered that the average brewery horse worked at the rate of 22,000 ft-lb per minute. So, with characteristic Scottish caution, he added 50% to this estimate, giving 33,000 ft-lb per minute. This still remains the standard definition of one horsepower.

JOHN HALL, *Romford, England*

By **LEON D COOK**, *Supervisor Substations, Commonwealth Edison Company*

About $40 million was spent during 1954 for new dc motors, generators, from 1 to 200 hp. So, far from being a dead duck, dc rotating equipment is back in the swim. And with this regrowth of dc in industry, commutator care takes on new importance. This timely info off the beaten path is based on the theme that . . .

COMMUTATOR CARE starts with use of right grade brush plus periodic inspection. Check on copper picking, bar streaking

Commutator film and brush know-how

► CLOSE STUDY of any commutator film shows it is made of copper oxides and brush materials plus a trace of dust particles picked up from the surrounding air. This layer is extremely thin. And it's this extreme thinness that accounts for the trouble often met in maintaining the most desirable film thickness, particularly at high speeds.

Lubricating properties of film help brushes operate at relatively low friction. Film lubricates because of a layer of water molecules adhering to, or adsorbed on, the graphite or carbon crystals at film's surface. Water comes from moisture normally found in atmosphere. This gives a clue to the rapid brush wear found at low humidity.

Film is formed by continual deposit of brush material from negative brushes of a generator (positive brushes of a motor) plus oxidation of copper at contact surface. While generator negative brushes continue to deposit material, friction of positive brushes is hard at work removing it. With time, the film is being removed by the positive brush at the same rate it is being deposited by negative. After this, film quality and thickness may pass through wide variations because of load, atmospheres, other outside influences. Sufficient film for normal operating friction and contact drop forms completely in about 80 minutes at 5000-fpm peripheral speed. But final point of equilibrium or stabilization may not be reached till 10 days or more after startup.

Most suitable film is often the classical chocolate brown layer generally referred to in the brush manufacturer's literature. Such a film, however, is more an ideal than an everyday occurrence. In some instances a heavy dark film can be maintained, and under certain circumstances this film may be the one best suited. In other machines such a film may be too thick, leading to . . . commutator streaking in brush-width paths, copper picking, high friction and brush chatter, short brush life and, finally, sparking at high brush and commutator temperatures.

On the other hand, too thin a film means rapid commutator wear, short brush life, high friction, and increase in commutator maintenance. An upswing in frequency of grinding and undercutting is most pronounced.

No rules predetermine the ideal film for any application. On a well-adjusted machine where a high contact drop is needed for satisfactory commutation, a heavy dark film generally gives best results. And best results include good brush life and minimum commutator wear. If brushes chatter, pick copper, run at high temperatures while commutator has a heavy film, swing over to a lighter coating. Quiet operation at lower temperatures should follow. With oxidizing chemical fumes or similar conditions, you may have to operate commutators with little or no film regardless of brush life or maintenance costs.

Film regulation is most important. If it is too thick, brushes are not sufficiently abrasive to remove deposited material fast enough. Simple corrective is a change to more abrasive brushes. But often where electrographite brushes are used on high-speed commutators, this is not practical. If abrasive brushes are introduced, resulting increase in brush friction may lead to high commutator temperatures and brush chatter. Following methods produce desired film yet sidestep the difficulties:

1. Increase brush tension when practical. Friction and temperature may increase but to some degree are compensated for by reduction in contact drop.

2. Change to graphite brushes. Abrasives may then be added with little friction increase. Since this material is not strong it is not suited for applica-

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Fundamental information in this article was first presented by the author in a conference paper before the AIEE during the 1954 fall meeting in Chicago, Ill.

Today's realistic approach to brush replacement

DOES SANDING HELP? Any new brush, even after careful sanding-in, will carry its own load plus some from full-seated neighbors. Reason: New brushes operate with about 10% contact for first few hours. Then assuming equal brush tensions, effective pressure of the new brush is ten times that of older brushes. Result is lower contact drop and more current in new brush than full-seated brushes.

LOAD DIVISION between seated and new brushes was checked with ammeters cut into brush shunts. Test data point out that unsanded brushes take full load and then some. If we look upon current conduction between brush and commutator as an arc rather than stationary resistors, some long-standing misconceptions will be cleared up. Further ammeter checking shows current division better between unseated brushes rather than those worn in.

WHEN REBRUSHING larger machines bevel each brush to an approximate fit. Then grind or sand commutator to provide a raw surface for new brushes. After brushes are in, operate machine with at least 25% of full load. If brushes are run in at no load, absence of ionized gas film under brushes leads to rapid wear, high friction and commutator streaking.

SPOTTY BRUSH CHANGES are best handled by using longer brushes salvaged from previous rebrushing. Since these are already surfaced, no beveling or sanding is needed. Using this technique, every path across commutator is subject to the same action and each brush reacts alike. If there is a disposition to pick copper (quite common on heavily loaded machines) all of the brushes on an arm will do so.

Final effect is lighter commutator film distributed evenly over the surface. In contrast, if worn single brushes are replaced with new ones, tendency is for each new brush to break through the commutator film at a single point, causing copper dragging and shunt burning.

prove basic links to dc motor care

tions involving high mechanical stress.

3. Use an abrasive graphite cleaner-brush in one or more arms. This is generally the simplest approach, but not practical where brushes operate radially or at a trailing angle 15 degrees or less.

4. Apply a brush seater or chalk stone to remove excess film. Leave it on a day or so until film stabilizes.

Where it is difficult to build up sufficient film, one or more of the following may come into the picture: (1) brush tension too great (2) excessive dust (3) copper picking (4) brushes too abrasive (5) machine running at too light load.

Other factors enter into any discussion of commutator film. Example: Where a machine is operating at full load, decreasing brush tension to increase film may lead to selective action (overloading some brushes and burning shunts). Here it may be best to replace brushes with type having greater film-forming ability.

Where copper picking is permitted to continue, loss of commutator film is bound to follow because of abrasive action of copper imbedded in brushes. To spot copper picking, examine brush faces for copper spots or a coppery sheen. But absence of copper at brush contacts is not proof that picking is not taking place. Sometimes copper does not remain on brushes, but is pulled away by rubbing action of brush on commutator. If this is happening, brush faces show a series of thin streaks starting at various points and continuing to brushes' leaving edge. Fine copper dust is also noticed on brush boxes and rigging.

Copper picking may stem from a number of causes: brushes off neutral causing excessive currents in brush faces, too little tension, high-frequency brush chatter, brush arms incorrectly spaced, overloading, too low a contact drop. Film cannot be adequate if machine load is too low to provide enough material on the commutator. Correct this by removing some brushes until remaining ones have a high enough current density.

Brush types are outlined on the following page. Give sufficient thought to selection of proper grade for each major machine. All types in chart, p 132, and many variations, are available from most brush manufacturers.

There is no pat formula for selecting the grade best suited for a machine. Even at this late date there is not enough know-how on tap, concerning properties of brush materials and machines, to make exact predictions in practice. The only ultimate test of suitability must be made in the machine itself. It is not wise to simply select a single "good" brush for all machines. Any brush, no matter how high its qualities, may give perfect performance on one machine and fail on another.

As the chart indicates, all brushes are made from four general classes of materials: *carbon, electrographite, graphite* and *copper graphite.*

Carbon brushes are less costly and generally restricted to machines of lower current density and speeds below those in modern equipment. Since many machines are comfortably within this range, the material still enjoys wide industrial use. Carbon grades give excellent results where (1) cleaning action is needed at low peripheral speeds (2) mica is flush and it is impractical to undercut (3) strong oxidizing fumes are present (4) brush-cost economy is a major factor.

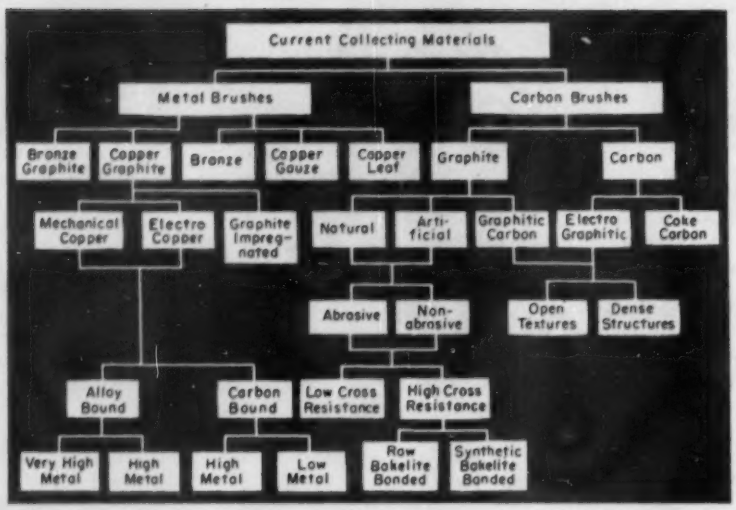
Electrographite has the same base as carbon but is processed at high temperatures in an electric graphitizing furnace. Treatment produces radical changes in material characteristics increasing its electrical and thermal conductivity, and rendering it much softer yet very tough. This change, as applied to brushes, develops a material low in friction, nonabrasive, resilient (ability

Make maintenance pay off

Every plant should have a definite program for blowing out brushes and armatures in addition to a routine check of brush length, tension and free operation in holders.

Expensive repairs are often made to be on the safe side or to make the commutator look pretty. Both represent a significant loss of time and money. Trick is to carefully analyze each potential repair and determine if it's really necessary, and at this time. But don't let the pendulum swing to the other extreme so that needed maintenance is neglected.

Time to grind can be determined by holding a pencil atop brush while machine is running. If grinding is necessary you'll feel a regular and definite vibration, timed to the machine speed.



NO EASY FORMULA is available for selecting the most workable grade brush. Only final test of suitability for any brush is that made in the specific machine under load

'Commutator film forms after about 80 min at 5000-fpm

to ride the commutator without bouncing), cool running, capable of carrying more current than carbon grades. This material loses its abrasiveness in the graphitizing process and so electrographite brushes have little or no cleaning action.

Lack of abrasive quality limits this material to applications where little of this property is required. Use of abrasive brushes (cleaners) of graphite material, applied to a negative arm on a generator in conjunction with the regular electrographitic grade, is often practical where additional abrasive action is needed.

Electrographite is made in both porous and dense structures that change its commutating performance considerably. On most applications the more porous grades excel in commutating ability, but with less life than the more dense grades. There is also less likelihood of brush chatter with porous structures. Also they are more resilient and ride a rough commutator with less distress. Brush with larger pores gives slightly more cleaning action than the same style with denser construction.

Because of unfavorable conditions often met in practice, the more porous brush is satisfactory and economical on most machines.

Graphite brushes are readily distinguished from the black carbon grades by their silvery appearance and soft flaky structure. High-quality graphite for brushes is a mined product, in contrast to carbons manufactured from base materials. It is not necessary to subject materials to high temperature in manufacturing graphite brushes. Therefore, it is easy to add the wanted amount of cleaning action. One of the most valuable properties inherent in this class of brush is that its abrasive action may be altered without change in grade. Most graphite grades for commutators are so constructed that resistance between heel and toe is considerably greater than lengthwise resistance. This adds to commutating ability because they suppress circulating currents in the brush face without increasing contact drop.

Graphite brushes cannot be made as mechanically strong as carbon or electrographitic grades. Also, graphite is more prone to selective action and shunt burning at high current density. For this reason their general application is often restricted. When properly applied, graphite brushes give quiet operation and long life with minimum maintenance.

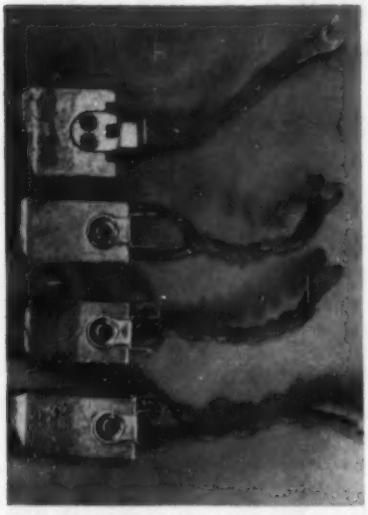
Copper-graphite brushes are a mixture of powdered copper and graphite, pressed together and baked at relatively low temperatures. Copper-graphite grades are primarily designed for slip rings or commutators with high currents at low voltages. Their low contact drop and high current capacity recommend them for low-voltage generators designed for electrolytic processes. Abrasive actions inherent in metal brushes are dependent on the proportion of copper; the more copper, the greater the abrasive action.

Copper content also governs current capacity and contact drop. Added copper increases current capacity and lowers contact drop. In selecting copper-graphite brushes, contact drop and film is always a factor since, with heavy currents involved, the heat losses at brush contacts may be considerable. Film should be as thin as consistent with satisfactory operation.

Maintenance is a big factor in assuring satisfactory commutation. And grinding and undercutting are major components in any maintenance plan.

Time to grind a commutator has arrived when regularly spaced bumps develop on commutator's surface. You can detect these bumps by holding a pencil on top of brushes while machine is in motion. Grinding is necessary when regular and definite vibration is felt, timed to the machine speed. Grinding may also be in order before a commutator is undercut. Here it is done to remove the axial waves or ripples left by brush wear. This step should be taken for proper operation of the undercutting tool.

With machine at rest, the following



SIDE WEAR does this to normal brush. Trouble traced to high commutator bars

peripheral speed'

is a tipoff when grinding is required: (1) Brush toes are chipped or broken. (2) Saddle of brush, where spring rests on brush top, shows wear. (3) Individual bars indicate burning or pitting. But don't confuse latter with some cases, where all commutator bars are not the same color. (4) Brushes show signs of side wear. This is wear on brush side where it is being pulled against side of brush holder by brush tension, friction.

Undercut all commutators having four or more brushes. With today's brush grades and maintenance tools, it is generally false economy not to undercut. Exception: Where it is impossible to eliminate oil and certain chemical vapors. If flush mica is decided on, brushes must contain enough abrasive to keep mica wearing away at the same rate as copper bars. This balance is seldom maintained in practice.

If abrasive is too severe, a proper film cannot be maintained, resulting in rapid wear of brushes and commutator. If abrasive action is too little, brush chatter and copper picking develops, followed shortly by streaking and grooving. Both require frequent grinding for tolerable operation. Flush mica is least troublesome when restricted to slower speed machines.

Undercutting may be a deep U or a shallow V; the U is generally best practice. But where it is adopted, bars must be chamfered after undercutting.

Commutators old? Then hold your V-ring pressures to 150 lb . . . or less

When commutator bars are loose, high or low, the cause can be electrical or mechanical. If the trouble has a mechanical origin, solution is to tighten the V-ring bolts. This taking-up on the V ring means bars are held more snugly. On new unseasoned commutators this reasoning is OK if bolts are tightened in accord with machine maker's recommendations. But on an older seasoned unit, a general tightening may make matters worse. If tightening is repeated, stress on bars may be enough to crack them at the V. They then tend to work their way out and eventually be thrown from the machine. What to do under such circumstances without a major overhaul?

USE TORQUE WRENCH when taking up on V-ring bolts. Check bolt tension after machine is hot. May be best to loosen bolts, bring back to 150 lb

Commutator operating at about full load has a temperature well above that of other machine parts. Hence, expansion of commutator bars is greater than the spider and other parts holding V ring in place. So there must be some means for handling this extra expansion of bars. And there is.

New mica between V ring and commutator provides for some movement between the two members. As mica ages it becomes less and less resilient till after 10 or 20 years it assumes almost a flintlike nature. Because of the reduced elastic properties of aged mica, old commutators must have less V-ring tension for satisfactory operation.

Here's the best way to tighten bars in *old* commutators when the trouble is basically mechanical: (1) After machine has been running, check V-ring bolts with torque wrench. Adjust for between 100 and 150 lb, depending on machine size. (2) If all bolts are above this pressure range, it indicates the V ring is too tight, leaving no room for expansion. This might cause some bars to buckle and result in high and low bars. Best bet is to loosen all bolts and bring tension on the V-ring back to within the 100- to 150-lb range.

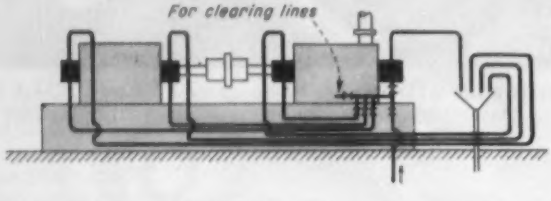
Timely PRACTICAL IDEAS *that will help you do a*

A new neoprene hose that's light

THIS NEW DOCK HOSE is so light that one man easily picks up the end and hooks it to a header. Conventional types of dock hose must be handled with mechanical cranes. It would take seven men to lift same length of conventional hose shown here at Consolidated Edison's Hudson Avenue Station, which is located in Brooklyn, New York.

Although new hose has a working pressure of 200 psi and safety factor five times as great, it can be bent and kinked without damage, springs back to shape instantly. Its neoprene tube and cover make it oil-resistant and give it superior resistance to aging and damaging effect of bright sunlight.

COURTESY, UNITED STATES RUBBER CO



Here's my idea on Pef's September headache

I'M AGAINST the series hookup shown because, if cooling line to one bearing gets plugged, you might lose all bearings. A modification, sketch, of the two shown by Pef is my idea. One man can see water returning and regulate each valve. With extra valve and fittings shown, any of the lines can be cleared by blowing back. Or if water fails, a temporary hose connected here would supply cooling water in emergency.

ED DUFF *Aurora, Colo.*

Another answer . . .

TO THE EDITOR'S NOTE on S S Thorpe's "Practical Idea," p 130, July 1954.

It looks as though Thorpe may get better operation all the way around if he uses soap on air lines to the draft controls and then repairs the leaks he finds in those lines.

H HOLCOMBE *Los Alamos, N. M.*

Protect cables from heat

HERE'S HOW to protect electric cables exposed to hot, outside temperatures without renewing them. Paint with insulating varnish and, while still wet, sprinkle a thick coating of finely powdered boiler lagging over them.

W E WARNER *Woodford Green, Eng.*

20 ways to reduce noise in air-conditioning ducts

MANY AIR-CONDITIONING SYSTEMS must run at peak capacity to handle added cooling load. In these older installations, high-velocity air is needed. But special silencers and larger air outlets are often required to absorb noise.

Lower air velocities are best in all air-conditioning systems. Air velocity should not exceed 100-120 fpm when directed at spaces where people are moving around. Hold offices to a 70 fpm minimum to avoid discomfort.

Avoid drafts by using ceiling diffusers with bottom grille dampers. With this system, air velocity can approach 3000 fpm, and will be diffused with lowered noise in spite of machines, columns and other obstacles. Smaller ducts and simplified layouts can save valuable space and initial installation costs.

Radio and TV studios require air velocities through necks of air diffusers in neighborhood of 700 fpm for minimum noise.

Set all air-conditioning equipment on shock absorbers to prevent vibration traveling through ducts. Separate the equipment foundations from main building foundations.

If fan wheels create turbulent air flows at discharge, minimize by adding turning vanes in well-padded duct elbows. Belt drives are preferable for motor fans, because they are easier to line up and noise cannot travel from motor to fan.

Branch ducts need hangers for stability. When passing through walls, have insulation at cross-through points to avoid wall noise pickups. Separate ducts for both supply and return prevent noise travel from one area to another.

Floating-construction duct mounting will almost eliminate duct noise. Keep elbows from branching too close to fan outlets.

Loose dampers and sharp edges in ducts mean noise. Give duct elbows enough sweep, or add turning vanes to prevent turbulence and one-sided air flow. Ducts to air diffusers should have an air velocity at least 100 fpm less than corresponding neck velocity.

Install sound-absorbing linings inside ducts and felt linings on dampers. Lining also gives air-conditioning gain, but consider allowance for linings as regards eventual air flow.

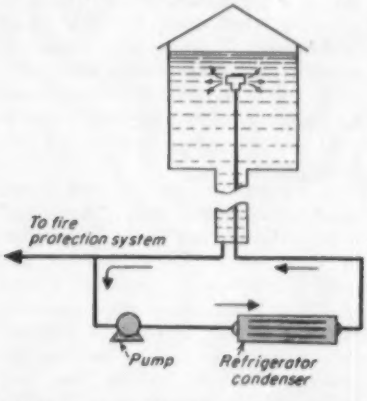
High-heat loads of more than 12 air changes per hour need high-capacity air diffusers. Equalizing deflectors in

diffuser necks gives quiet distribution. Felt padding vanes and equalizing damper blades also reduce noise.

All joints between ducts and air diffusers should be flexible. Diffusers should be tight against ducts to prevent air leakage, which adds noise to system.

All sound waves diminish in intensity as they move away from noise source. Air diffusers at ceiling are quieter than in walls, even if wall outlet is one foot below ceiling. These ideas are practical.

L W FITZPATRICK
Jefferson City, Mo.



Now, condenser water prevents tank freezing

WHEN WE PLANNED a new warehouse with office building, the insurance company required us to provide an elevated 150,000-gal water-storage tank. It was for positive water supply for our sprinkler fire-protection equipment. We had no central heating system so to prevent freezing we installed a standby hp-boiler to heat water in this tank. My experience with this size tank in some latitudes is that heating costs from $500 to $800 per season.

We hooked up water-heater lines for tank with our cooling-water lines from refrigeration condenser, sketch. This bypasses the watercooling towers and circulates through the water tank in winter. System is so successful that we never started standby boiler last winter.

Our water did not get below 45 F, which is a good temperature to give high efficiency in our refrigeration compressor equipment. We didn't use our cooling towers during a season that normally calls for close watch to prevent freezing. Based on this experience, we are making the same type of refrigeration-condenser water-heating installation in two other plants.

D WEUM *Minneapolis, Minn.*

What would you have done?

NEW HEAT-TREATING FURNACES had been tested, ample butane supply was on hand, and the Government was insisting on prompt delivery of heat-treated parts. Three furnaces were filled, butane gas was lighted, automatic temperature recorders began drawing temperature line, and production was rolling. I was mechanical engineer on the job—my first experience with butane in industry.

Fifteen minutes later temperature started falling, gas supply had weakened so operator turned on more gas. In ten minutes gas was gone again and operator opened line some more. He also switched on our spare tank, then sent word that first tank was empty, had better be changed.

I knew tank was full, just couldn't be used up in that short time. So 15 minutes later I visited our heat-treating department to check on the trouble. Operator was excited as second gas cylinder was failing fast. He had turned on extra gas twice. He thought someone had connected two nearly empty cylinders to the furnace supply line, but I knew better. I saw cylinders weighed just before they were connected to supply line.

Heat fell again and operator turned burners on full, was so worried he could hardly talk. As pressure dropped again, furnace charges would be lost.

I ran into small brick yard-building where two bottles of butane were connected to feed line. Everything looked OK. Valves were open and no sign of damage to pressure-reducing valves. I was stumped. I grabbed valve on one of bottles to make sure it was open and got a surprise—it was ice cold—and so was bottle ice cold. Answer to our trouble hit me like a ton of bricks.

Liquid butane was evaporating too rapidly for supply of heat being absorbed through steel shell of bottle to maintain rate of evaporation. So it was rapidly cooling itself, liquid temperature was dropping. Soon it would reach boiling point and thus reduce gas supply to almost zero. More Btu's were needed to supply latent heat of evaporation and there was no heat available.

Outside, a laborer was hosing down the yard. I got a hunch and ran to him, there was no time to explain things. I grabbed the hose, ran back to the brick shed and turned water onto the two cylinders. The 75-F water was hot to cylinders, which probably were about 20 F. Five minutes later heat-treating furnace operator ran out to say he was getting plenty of gas. He was astounded when I told him the cylinders hadn't been changed.

Next day we installed a steam radiator in the shed and had no further trouble. What would *you* have done?

G P PEARCE *Albuquerque, N. M.*

Marking gaskets for proper installation

GASKET on our diesel-engine manifold was installed improperly causing head to crack. Gasket is between water manifold and head of diesel engine.

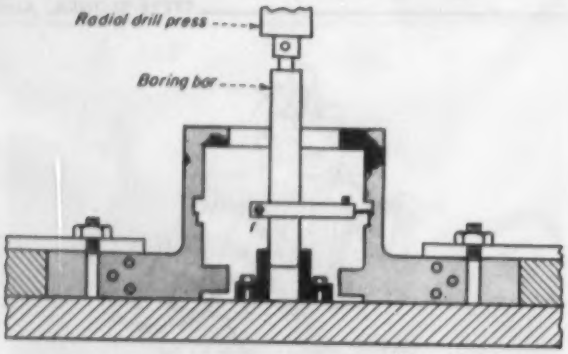
To prevent this happening again, we painted top edge of gasket red. That reminds mechanic installing gasket that this edge is top side of gasket. Then foreman or man in charge can check to see gasket is properly installed.

M L MONSON *Fosston, Minn.*

(*Continued on page* 136)

More PRACTICAL IDEAS

Begins on page 134



Here's your 'trick' of the month

WE HAD TO DO some internal machining on the high-pressure seal of our 35,000-kw steam turbine.

Reason casting had to be machined was that horizontal joint of seal leaked. We machined it on planer—then when two halves were bolted together, bore was ellipitical—so it had to be bored.

Casting was too large to swing in lathe and we had no boring mill. But job could be done on our radial drill press as it had a 39-in. arm. I made a boring tool with bushing, sketch. The 35-in. casting was clamped down on parallels, placed on drill press table.

After truing with dial indicator, tool was placed against casting and tightened, then cut taken. We kept this up until cut was right diameter. It solved the only serious problem of this rig—that of adjusting tool against casting.

Vertical travel is limited to height of bottom guide bushing, but tool holding bar is adjustable to any position on boring bar. So result is a very practical boring mill. Since that first job, we have used our radial drill press in this way on many large castings with good results. What do readers think?

D P SCHOTE *Saginaw, Mich.*

What we'd do for RJA's September headache

ANDERSON took a big chance. Had he become unconscious before getting out of that tank it might have been too late. His boss, trying to assist him, could have checked out also. As his plant is a laundry, there are always old sheets, pillowcases, ironing-board covers, etc, around. Also safety pins to tag batches and wire coat hangers. With these he could make a cloth tube, then beg, borrow or steal an office fan.

With one end of tube over fan, he could have a large volume of fresh air directed near his head. Exhaust would flow out past his body and out manhole around the feed-in tube.

If no fan and boiler were close enough, he could reinforce tube, then run one end into boiler ashpit door. He'd have a low-pressure high-volume suction tube, which could be placed close to freshly painted surface.

A word of advice to Anderson. Have a chest X-ray *immediately*. Paint may have had some chrome compound, which causes trouble. I know, as I've a hole through my nose from chrome compound. I was working in a tannery.

F L GILLMOR *Albany, N. Y.*

I HOPE Anderson realizes how near he came to greeting St. Peter at the pearly gates. Almost all the factors that make for sudden death were present. Just a little static spark from rubbing clothes against the tank wall, or breaking the extension lamp bulb would have made work for the undertaker.

Eye irritation, which forced him out of the tank, saved his life. Deadly condition of oxygen deficiency was there. While garden-hose idea was a stopgap of sorts, it's extremely fortunate that paint did not have a benzol or heavy synthetic vehicle. Either of those fumes can kill when breathed through the nose. Remember, he said nothing of using a nose clamp to force all breathing through mouth.

Some type of large, nonsparking fan could have been rushed into service. Or, he could have used compressed air to evacuate deadly paint fumes and supply air inside tank. Then, too, lighting could have been indirect from outside tank by a directed beam. A spray gun will do the job in one-half the time, if he has to do it again.

P C ZIEMKE *Oak Ridge, Tenn.*

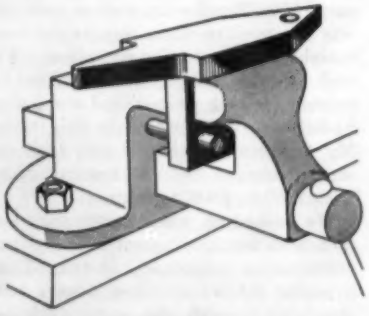
Aluminum-base lamps need not stick in socket

POWER mentions pros and cons of group lamp replacement from time to time. One part of organized lamp maintenance is problem of increased use of aluminum for bases of incandescent lamps. Aluminum-base lamps, subjected to dampness, fumes and corrosive atmospheres, are likely to stick so tightly in their sockets that removal without breakage may be impossible.

In large factories, where thousands of electric lamps are installed, cumulative time and effort of replacing lamps is enormous; even in smaller plants this is a big factor. While I have no statistical verification, fact that group replacement of lamps is a subject of concern to POWER readers shows this to be true. Add to this delays caused by seizure of aluminum-base lamps in their sockets, and you can have a very large figure.

Group maintenance of these lamps can be speeded up sharply. "Aquadag," a dispersion of "dag" colloidal graphite in water, coated on threads of aluminum-base lamps, prevents seizure from high reactivity of aluminum. Lubricating quality of colloidal graphite reduces static friction, as well as corrosion or galling, between base and socket so bulbs unscrew easily. Applied to metal surfaces, material is a good conductor of electricity, and has a negligible coefficient of expansion.

A CRANKSHAW *Port Huron, Mich.*



Sturdy vise anvil

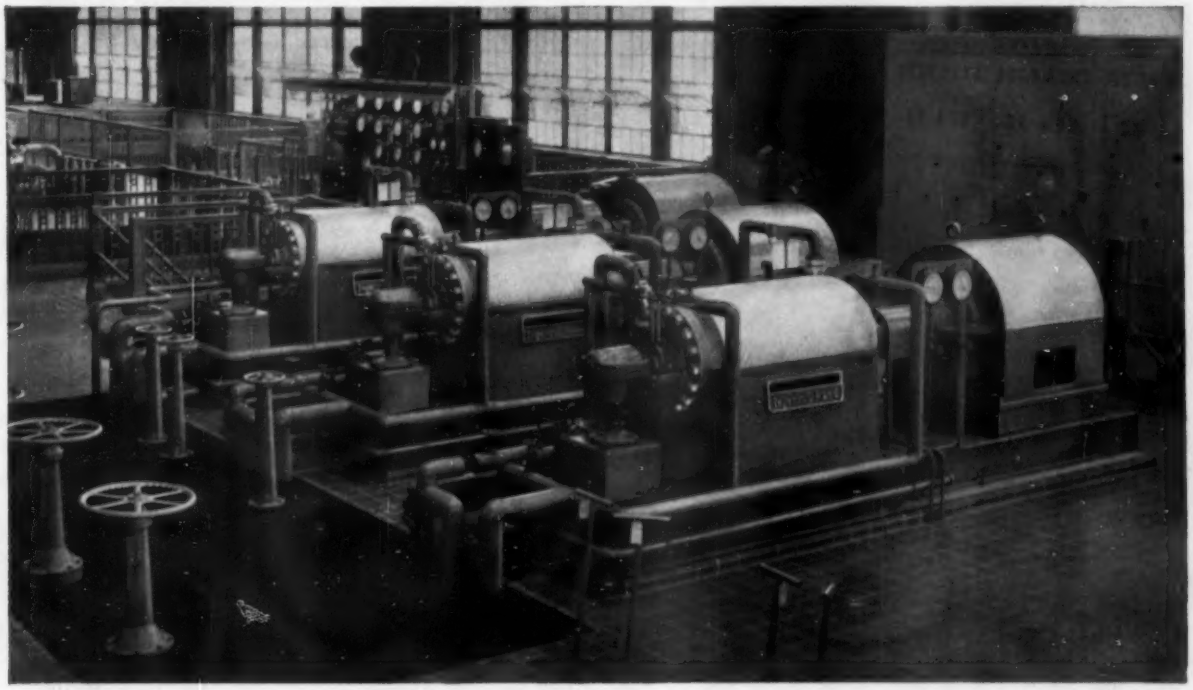
IF YOU HAVE THE TIME, make the rugged vise anvil in this sketch. It's a small task to saw one out of a section of I beam or piece of rail. Make it fit your vise, using a couple of $\frac{5}{8}$-in. pins through web section to lock it in vise. Then when you hammer on horn, or hardy end, it won't move. Vise is handy for small work in maintenance.

C H WILLEY *Penacook, N. H.*

(*Continued on page* 138)

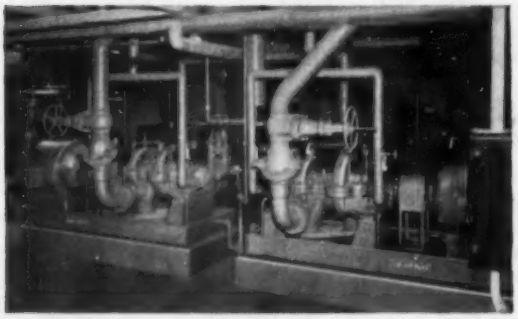
STANTON STATION of THE SCRANTON ELECTRIC CO.

served by Ingersoll-Rand boiler feed pumps of proven dependability and high efficiency



Three 475 gpm, 1735 psig 10-stage Class CHTA units chosen for 40,000 kw Unit No. 3 . . . .

Ingersoll-Rand "double-case" boiler feed pumps have stamina and endurance to meet the needs of The Scranton Electric Company and many other utilities throughout the nation.



Also installed at Stanton Station: two Ingersoll-Rand Class 4GT two-stage horizontally-split centrifugals in ash sluice service. Gilbert Associates, Inc. were consulting engineers for the installation of Unit No. 3.

A vertically-split inner assembly is enclosed in a heavy forged steel outer housing. As a result of this sturdy cylindrical "double-case" construction—and other I-R features such as leak-proof metal-to-metal joints, stainless steel fits, and thrust-free running balance—these pumps have an unusual record of long-trouble-free service in high pressure installations. Maintenance has been simplified—and reduced to a minimum.

See your nearest I-R representative for further information on Ingersoll-Rand pumps and other power plant equipment of proven dependability.

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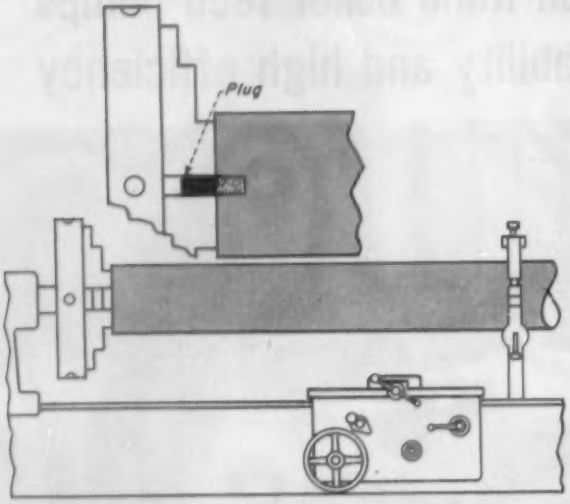
More PRACTICAL IDEAS

Begins on page 134



Why didn't Marmy try this idea?

M SURFACEBLOW, in Aug POWER, p 126, shows how he turns down end of long shaft in a short lathe. I've had same problem many times, but use a different method, sketch. First, I drill holes in both ends of shaft. Then I tap for pipe threads and screw in a special pipe plug. Size of plugs depends on shaft size they must support. Our shaft was 5 in. diameter and 11 ft long. Plugs were made of 1 1/16-in. steel, extended about 1¼ in. from shaft ends. I'll admit drilling and tapping is toughest part of job.

Place shaft in steady rest in lathe, same as Marmy did. But pipe plug is chucked and shaft trued up. In this way you need no follower and can use cross feed and carriage for machining.

When we finish, we take out steel plugs and use them on next job.

M B THOMSON *Amsterdam, N. Y.*

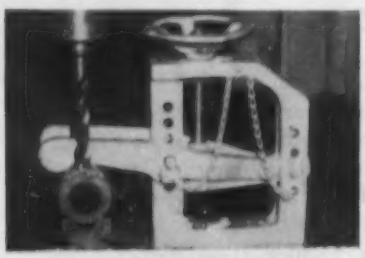
How's this for an 'emergency' solution?

ONE FREEZING DAY last winter, shortly after someone complained our main office was getting cold, I found water running down from open end of a vertical air bleed. Bleed is connected to heating return-system pit-pump No. 1. Cause was brush failure in repulsion-induction motor on pit pump No. 2, in series with No. 1. Returns get back to receiver as they are several feet above the boiler-room floor and pumps. There was nothing to do but break a joint at pump No. 2 and let the hot returns run to waste. That lost plenty of heat, fuel.

It occurred to me that a sump pump, such as is used to drain a cellar automatically, might work. Local plumber had one in stock, and I saw it operating in our boiler room. We placed it in a tin washtub, with returns discharging from heating system into the tub. This pump ran at least once every minute, 24 hours a day for several weeks. It worked so well that we were in no hurry to get No. 2 back in operation. Returns handled were very hot.

Not only does this pump handle returns splendidly, but we also find it very handy for filling boilers with hot water from receiver, after they are down for inspection. We can fill them rapidly, and can pump against some 8 or 10 psi. This gives us a chance to test handhole and manhole gaskets for leaks before getting steam on boilers.

A H PARKER *Peterborough, N. H.*



Clamps hold work safely

SAFETY ADJUSTABLE CLAMP attaches to a T-slot table and work can begin. Adjustable pins are set, work inserted, leverage wheel turned—and you're ready.

Photo shows 12-in. model designed for heavy-duty work. But a 6-in. model for general machine-shop use and a 4-in. model are also on market. Clamp works just as well on side of table as on top.

There are no nuts to loosen every time you remove a piece and start a new one, as with hold-down clamps.

Courtesy, Safety-Adjustable-Hold-Down Clamp Co, Brunswick, Ga.

Saw sheet-metal strips

SAWING NARROW STRIPS from sheet metal, photo, produces a strip free of kinks and twists. Just mount piece of sheet material in bench vise and back up for full length with wood. Set saw blade at right angle to normal position.

Scribe line to indicate position of cut on surface of sheet material. Align this line with top surface of vise jaws. Starting at one end of material, run saw cut along line with saw blade guided by top surface of front jaw. When cut runs off end of vise jaw, move material in vise and reset. Clip prevents bending.

C T BOWER *London, Eng.*

Better oil- and gas-burner ignition

SMALL, COMPACT BUTANE and propane gas torches, the ones with the replaceable "beercan" fuel container, are easily adapted through a piece of copper tubing for use in lighting oil and gas burners.

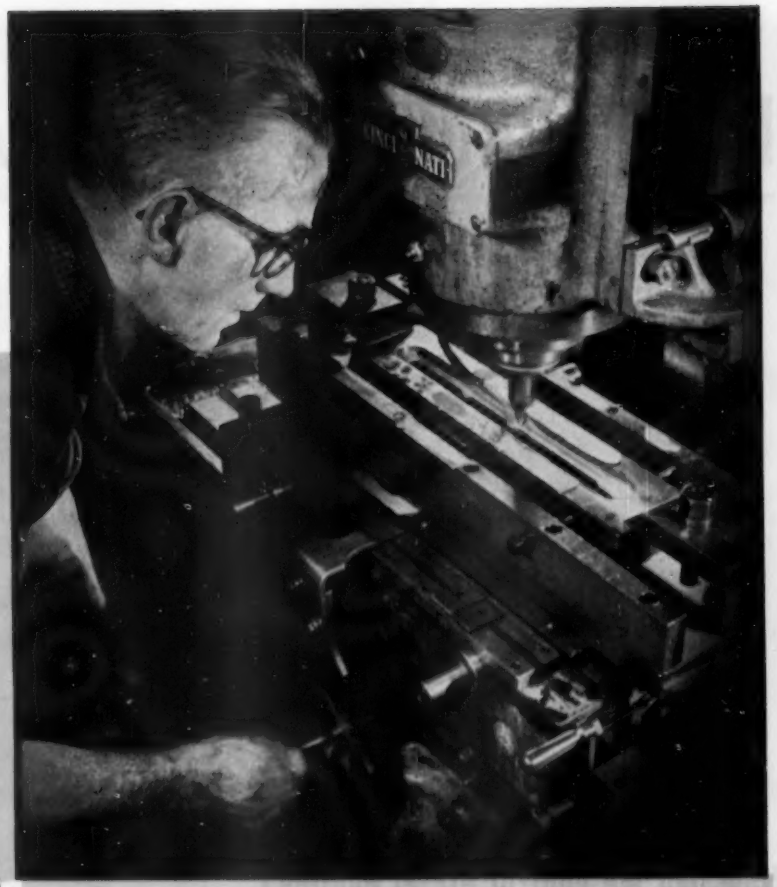
These small torches have a life of 12 hours and eliminate smoke and grime from conventional oil-soaked flare.

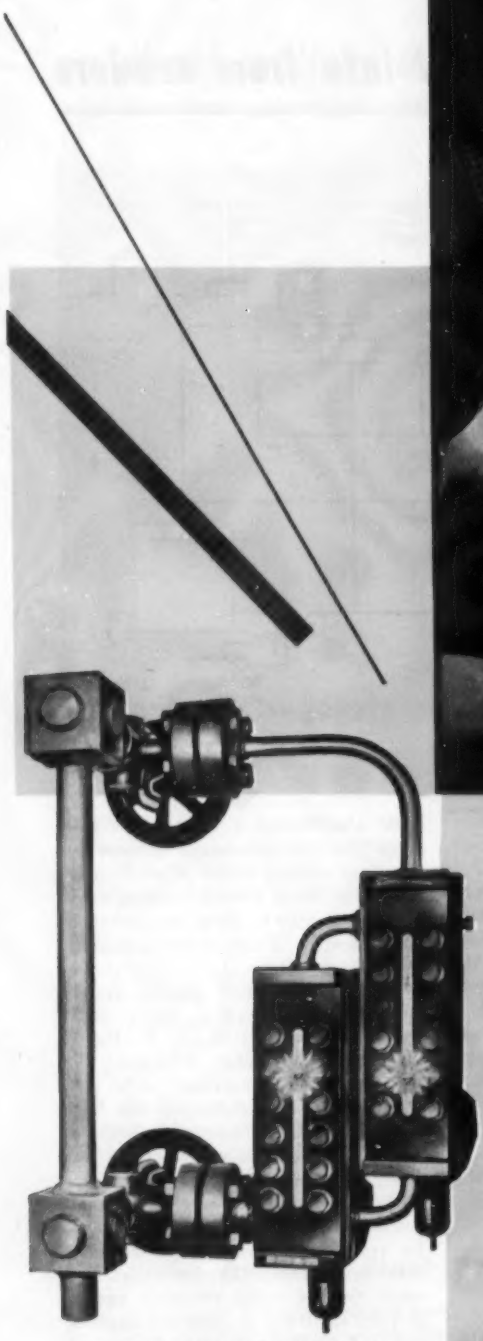
L W FITZPATRICK *Jefferson City, Mo.*

Did you know . . .

THAT PISTONS usually wear oval from crankshaft misalignment? And crankshaft often gets that way from main bearing wear. This causes crankshaft to slope. Because piston is not in true vertical position, it bears hard on one side of cylinder wall—wearing it oval.

W E WARNER *Woodford Green, Eng.*





Yarway High Pressure Boiler Water Gage with separated-design flat glass inserts. Write for Yarway Bulletin WG-1812

HE'S A SPECIALIST ON STAINLESS STEEL INLAYS

• A dentist? No.

He's a Yarway craftsman. In the picture above he is milling a gasket groove in the stainless steel facing that is used for this important part of a high pressure boiler water gage body.

The man is important; so is the inlay.

The man is typical of the skilled workmanship that goes into every Yarway gage, blow-off valve, steam trap or other product —workmanship that makes no compromise with quality.

The stainless steel facing is typical of advanced Yarway engineering design. That inlay is but one of twelve basic improvements made in Yarway high pressure water gages.

When buying boiler water gages as well as other steam plant equipment, measure the cost in terms of good engineering, quality, workmanship, and dependable service.

"Make Yarway your way."

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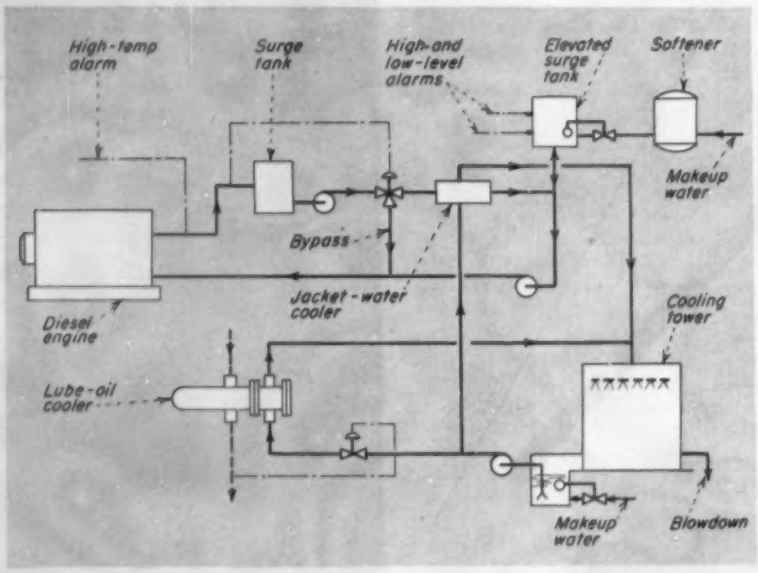
YARWAY

steam plant equipment

BLOW-OFF VALVES
WATER COLUMNS AND GAGES
REMOTE LIQUID LEVEL INDICATORS
EXPANSION JOINTS
DIGESTER VALVES
STEAM TRAPS
STRAINERS
SPRAY NOZZLES

PLANT PROBLEMS . . . *helpful info from readers*



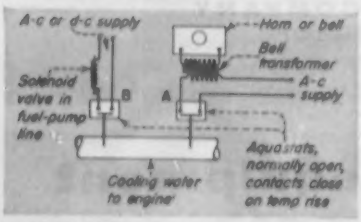
How can we control diesel cooling?

HERE ARE THE FACTS: Our industrial plant has three 1200-hp diesels. They drive generators supplying dc for process electric loads. Each engine has its own cooling tower.

Recent water shortages and high ambient summer temperatures have caused engine-cooling trouble. It takes almost all an operator's time to keep engine operating temperature below safe limit on a hot day.

What kind of controls can we use to (1) regulate cooling-water temperature (2) shut the engine down when water temperature is too high (3) warn the operator? Is it possible to use controls on each tower, or must they be fitted to the engine? Which control system gives the best protection?—*FL, Nov Power*

Here are the answers



RE-EVALUATE COOLING TOWER and concentrate effort on more effective heat transfer to the cooling water. Low water velocity and clogged piping in the cooling circuit reduces heat-transfer rate. It is also possible that the cooling tower is too small to provide needed cooling.

Immersion-type aquastats in the cooling water, set up as shown, left, warn operator and stop the engine. Temperature settings for these units depend on operating conditions. Aquastat *B* is set a few degrees higher than *A*, so operator can take suitable action following horn warning. If this goes unheeded, aquastat *B* cuts out engine.

C Bachmann *Rego Park, N. Y.*

HEAT BALANCE for a diesel engine indicates that the percentage of heat rejected to cooling water is nearly constant at all loads. Thus the cooling-water flow rate can be in direct proportion to engine output. A rule of thumb calls for 40 gpm per 100 hp.

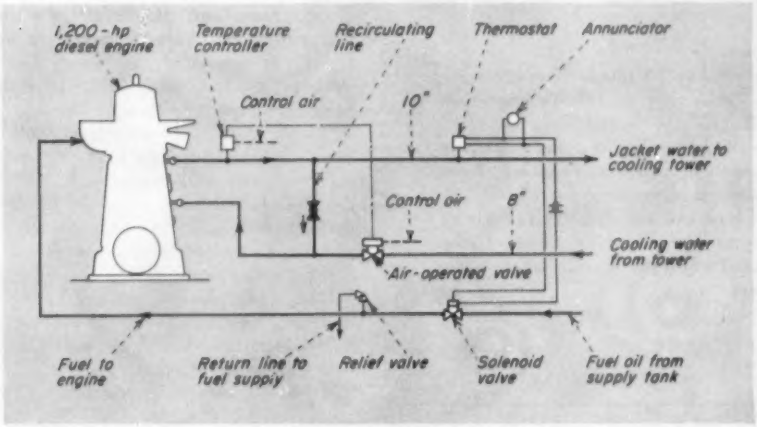
The average diesel cooling system operates properly with a water outlet temperature of 140 to 180 F. But if scale-forming tendency is present, the observed water temperature can be misleading since the engine is not fully radiating its heat. Lower water outlet temperature reduces scale-forming tendency. But excessive cooling can cause condensation of water vapor in the combustion products, leading to corrosion. To avoid high thermal stresses, temperature difference between inlet and outlet cooling water shouldn't exceed 20 F for small and medium-size engines, and 10 F for large engines.

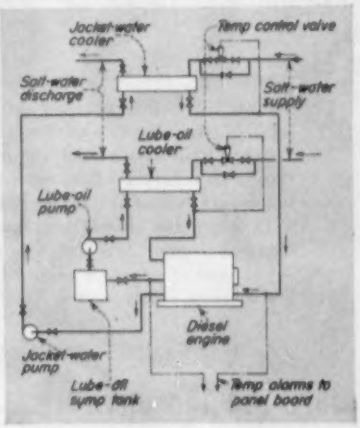
Sketch above shows a closed-circuit cooling system using treated water for the engine and raw water for cooling-tower loop, including jacket-water and lube-oil coolers. Three-way control valve, before jacket-water cooler, permits bypassing it if outlet water temperature is below permissible. An interlock may be installed to prevent starting up the engine when cooling water is not flowing through the jacket.

H B Wayne *Brooklyn, N. Y.*

on diesel cooling, control-valve overhaul

HOWARD KALLEN, *Assistant Editor*





Breugelmans suggests control system...

FORMULA based on the rule that it is advisable to install enough water capacity to handle 3000 Btu per hr per hp gives required amount of cooling water:

$$W = \frac{hp \times 3000}{t_2 - t_1} \text{ lb per hr}$$

For a 15-F cooling-water temperature rise then,

$$W = \frac{1200 \times 3000}{15} \div (8.33 \times 60) = 480 \text{ gpm.}$$

Supply line can be 8 in. for a velocity of about 3 ft per sec; 10-in. discharge line will pass cooling water at 2 ft per sec. Piping should be either cast iron or galvanized steel, with gate valves instead of globe valves, to decrease flow resistance at these points.

Control-system sketch, above, shows one engine cooling-water system used to maintain maximum water temperature rise of 15 F. This could be set for a differential from 125 to 140 F. At full temperature rise, control valve is almost wide open, thus passing more cooling water. As insurance against water shortage a thermostat is inserted and set at 155 F. This closes fuel-supply valve and sounds an annunciator when cooling-water temperature exceeds 155 F.

During cold weather, cooling water can be recirculated by manual control.

A J BREUGELMANS *New York, N.Y.*

Grier says separate coolers

SEPARATE HEAT EXCHANGERS for jacket water and lube oil will ease problem. Our cooling water for these exchangers is salt water. But any suitable source of raw water serves the purpose. By having discharge valves on the coolers wide open while inlet valves are throttled, we can regulate jacket cooling-water and lube-oil temperatures very closely, thereby assuring good cooling.

Temperature alarms at panelboard give the operators warning of excessive cooling-water temperatures.

A L GRIER *Staten Island, N. Y.*

(*Continued on page 208*)

Who answers Plant Problems?

Lawrence W Fitzpatrick has been in and around water all his life. He has been concerned with power machinery of many types—from a "one-lung" steam hoisting engine (which, incidentally, replaced three mules) to equipment operating under water. During World War I he directed fabrication of submarines.

Larry was also supervising engineer for the State of Missouri during WPA-PWA days. And in World War II he designed and constructed water-purification systems for the Mexico RR Co.

He is now Chief Engineer for the Missouri Dept of Corrections at Jefferson City. In this position he has had wide experience with all types of power equipment in Missouri's "big houses." One of these penal institutions was the scene of the execution of the infamous Hall-Heady kidnappers, December 1953.

More answers to plant problems on page 142

More PLANT PROBLEMS

Begins on page 140

What's a good valve-overhaul program?

HERE ARE THE FACTS: Our plant has 30 one-inch diaphragm-operated pressure-reducing valves. Since they are all on important services, they have to perform well.

What basis can we use for inspecting, overhauling and replacing these valves? How often must we open them for inspection? What is the safe life of the diaphragm and other working parts?

If inspection should be regular, how can we simplify the work? I've heard about test stands but do not know how to construct one. What kind of program should be used when there are a larger number of such valves?—*SH, Nov Power*

Here are the answers

PERIODIC INSPECTION during operation or at low loads keeps valves in good condition. Stem and diaphragm are the things to watch. Valve stem must move freely in response to air-pressure changes on the diaphragm. If stem moves in spurts, examine diaphragm. If no longer pliable, it should be replaced. Too tight stuffing-box packing can cause jerky valve-stroking action.

Travel can also be restricted by dirt between disk and seat. Occasionally a rusty valve spring, which results in irregular action, must be replaced.

Inspections can be made at almost any time. And it shouldn't be necessary to remove a valve for inspection if it is found to be functioning properly.

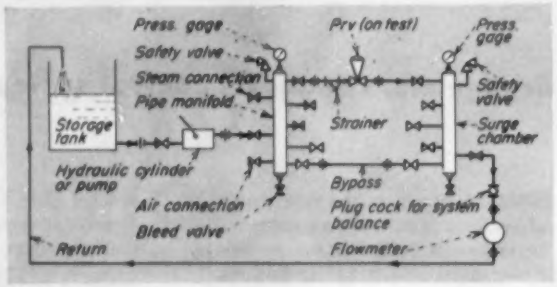
A J Breugelmans *New York, N.Y.*

Inspector Jones VALVE CHECK CHART Date 2-1-66

VALVE NO.	OPERATION	LUBE	DIAPHRAGM	PACKING	AIR SUPPLY	STEM	PILOT OPER	SPRING	STEM NUT	GLAND	MISC
PRV-1	ok	yes	ok	ok	low	ok	ok	ok	ok	ok	check next time
PRV-7	ok	yes	ok	slight	ok	ok	ok	ok	adj	adj + check	

Remarks: —

Signed by —



Higgins proposes check chart, test stand

NUMBER your pressure-reducing valves, PRV-1, PRV-2, etc, with metal tag and list them on a chart like the one shown above. Inspection of these valves is staggered so Jones checks valves numbered PRV-1, PRV-7, PRV-13, PRV-19 and PRV-25. Smith checks PRV-2, PRV-8, PRV-14, PRV-20 and PRV-26. Each operator thus checks his assigned group of five valves once every six days. And no one operator is unduly burdened.

Efficiency of this system depends on carefully filling out the check chart and reporting all valve troubles.

Life of parts varies considerably depending on severity of service and materials used. But it's wise to check with the manufacturer on the expectant life of critical parts. He may suggest stocking a complete kit of replacement parts, including complete top works for diaphragm pressure-reducing valves, to make a quick changeover if necessary.

Test stand shown above is not difficult to construct. Remember to select piping for maximum pressures to which it may ultimately be subjected, allowing for safety factors in accordance with pressure piping code. Stand makes provision for testing with air and steam as well as hydrostatic tests. Discharge-line flowmeter is often valuable.

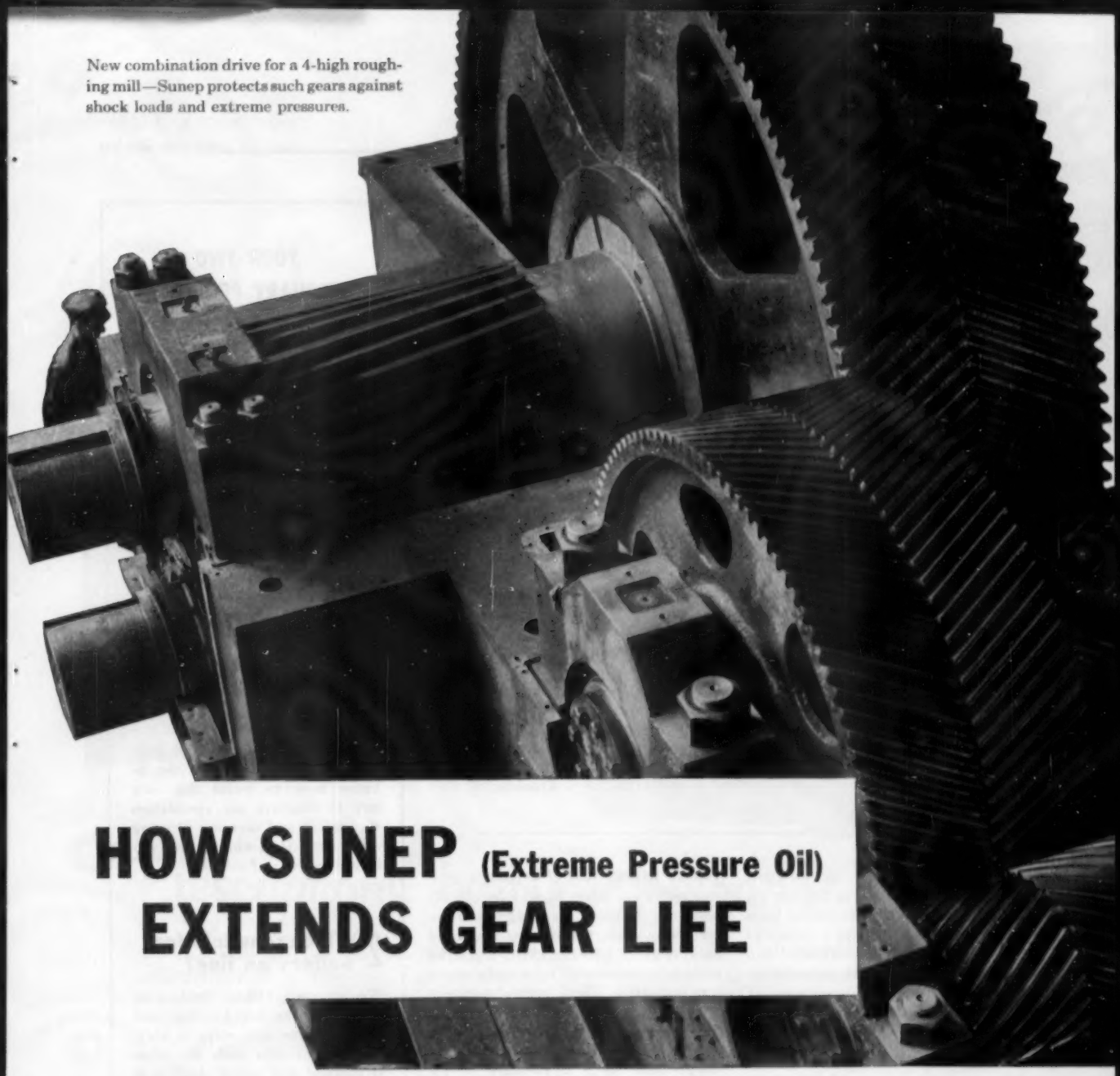
S R Higgins *Long Beach, Calif.*

VERY LUCKY is *SH* to have 30 diaphragm pressure-reducing valves of the same size. Good method consists of taking these steps: (1) Buy one to three spare valves. (2) Make weekly inspection for signs of poor operation. Where there is trouble, replace and overhaul valve. Tag inserted valve with replacement date. (3) Tag repaired valve and keep record of part that failed. (4) Make a yearly inspection. Disconnect the diaphragm tube, taking off diaphragm housing and unscrewing the valve bonnet. (5) Check for partial stoppage of diaphragm tube by corrosion. (6) See that adjusting nuts move freely on threads. (7) Metal diaphragm should not be removed unless there is reason to believe it is cracked, leaking at the edges or insensitive. Used metal diaphragm should not be put back in the housing. Replace it with a new one. (8) Rubber-diaphragm failure may be due to old age, oily atmosphere or overheating. When cutting new diaphragms, make sure not to use old rubber. (9) Repack valve stems at each overhaul and check them for taper wear. When repacking stem, screw nut down tight on the last packing ring inserted. Then back the nut off a full turn.

O Le Brace *Oroville, Wash.*

(*Continued on page* 144)

New combination drive for a 4-high roughing mill—Sunep protects such gears against shock loads and extreme pressures.



HOW SUNEP (Extreme Pressure Oil) EXTENDS GEAR LIFE

The advantage of running your machines at high speeds and under heavy loads can be quickly lost if your extreme pressure lubricants turn thick, lose film strength, or cause gears to corrode.

Sunep gives your gears better protection longer. Unlike many E.P. oils, Sunep is made from highly refined, premium grade oils skillfully blended with chemical additives that do not drop out during operation or in prolonged storage. This accounts for several rare user benefits: long life at extreme pressures; absence of corrosion—even on bronze; rust protection for steel parts; clean gears and bearings as a result of the oil's high stability.

Primarily a lubricant for enclosed gears, Sunep has proven to be highly effective on bearings and screws working under extreme pressures. Because of its exceptional clinging characteristics, Sunep guards against metal-to-metal contact during the early moments of machine operation after shutdown. FREE BULLETIN. Tells all about Sunep. Get your copy. Write Dept. P-2.

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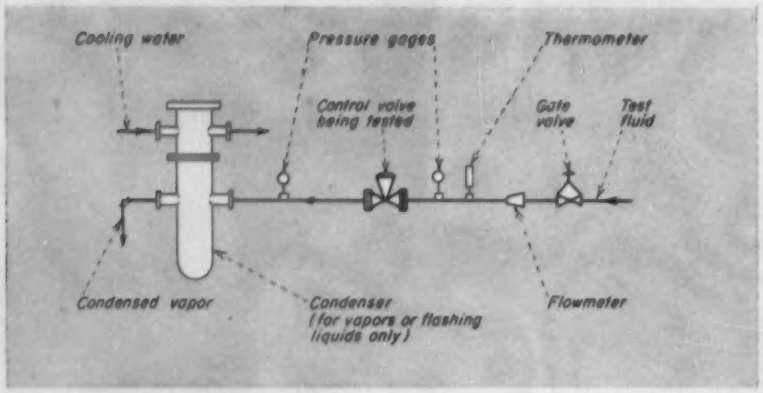
Refiners of famous High-Test Blue Sunoco Gasoline

More PLANT PROBLEMS

Begins on page 140



EROSION AND CORROSION are important criteria for frequency of inspection. If valves are used for reducing pressure of hot liquids, flashing may be expected. This can lead to early erosion if right valve materials aren't selected. Stainless steel often licks these problems.

For erosive and corrosive fluids, monthly inspection is usually required. For less severe service, semiannual or annual inspection is adequate. To do a good inspecting job, valve must be isolated from rest of system. A block valve, before and after the control valve with a globe valve for bypassing, permits taking the valve out of service without interrupting production. After replacing worn parts, test for seat tightness under full operating pressure. Often it is cheaper to replace small valves than to renew parts because of time and labor involved.

Suitable test stand is shown above. If fluid is a vapor or flashing liquid, use a condenser following the valve.

H B WAYNE *Brooklyn, N. Y.*

SPARE VALVES, maybe one or two, should be kept on hand so *SH* can replace each valve on an alternating basis of once a year. In this way a valve can be taken out of service, overhauled and used to replace the next valve to be overhauled. This system needs a piping arrangement where all valve connections are same thread or flange size.

A C VEEN *New York, N. Y.*

YEARLY REPLACEMENT of all rubber diaphragms is automatic in our plants. In addition, we conduct a monthly check and renewal of worn parts that has paid off in quality and length of valve service. All small-size valves are installed with nipples and unions for fast emergency replacement. And spare valves are already made up with this nipple-union fitting combination.

With seasonal or process-load variations we use two smaller-size valves in parallel. This cuts large control-valve maintenance and always keeps valves in nearly full-open position, minimizing wire drawing and erosion.

L W FITZPATRICK *Jefferson City, Mo.*

YEARLY INSPECTION of important pressure-reducing valves should be strictly followed. Replace diaphragm and inspect seat, stem, spring, seat rings and packing gland for wear. After replacing worn parts reassemble valve and connect it to test stand. Check control accuracy at several high-pressure-side readings and several different flow rates. Also test for positive cutoff with no flow on low-pressure side. If pressure on l-p side gradually builds up, seat is leaking.

J W SMITHWICK *Washington, D.C.*

SERVICE CONDITIONS govern frequency of inspection. It is usually a cut-and-try process at first. In the course of a year's trial period *SH* should arrive at a standard schedule. Under favorable circumstances valves should give good operation from 18 months to three years. But severe service could cut this down to as little as a few months.

C G HOWARTER *Canton, Ill.*

READER A A Hunnewinkel of Woodstock, Ill. also sent a good answer for which we lacked space.

YOUR TWO FEBRUARY PROBLEMS

1 What's best means of waste disposal?

We have to dispose of one to five tons of refuse each day, depending on production rate. Besides regular papermill waste containing trash, metalclad hoses, etc, there is paper in the form of trimmings and multiwall bags. This was formerly burned at a dump, but we now stockpile chips so we abandoned the practice of dump burning.

A temporary metal incinerator was built in hexagonal form, 16 ft across corners and about 10 ft high, with a sand floor. But we found that the center of a bale of rejected bags is virtually fireproof if set on the sand bottom. Since this incinerator is to be replaced, we would like to know how to build the new one to improve air circulation through it and increase burning efficiency. Also, what is best way to unload waste?—*WRM*

2 Which schedule for boilers on line?

We use two 110-psi boilers to supply steam for heating and process. One unit stays in service three months while the other is cleaned and rested until it is scheduled to take over.

Our insurance company says we can save money on premiums if we switch over to 6-month periods instead of 3-month. Naturally we would like to make the saving, but our engineer feels he knows his boilers better when he shuts down oftener. He sees no advantage in operating on a 6-month schedule.

We would appreciate advice pro and con, with supporting reasons for recommendation.—*EC*

Will you help readers who sent problems? Extra pay for photos, sketches.

BETZ • *A Great Name*
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"Prescriptions" by the truckload!

Solving industrial water conditioning problems effectively and *economically* requires exacting engineering techniques.

There are no stock answers . . . no stock chemical treatments.

We realize this perhaps more than anyone. In fact, we make a business of it.

For example, each year at our mixing and formulating plants in Pennsylvania, Texas, California, and Quebec, we blend and ship thousands upon thousands of different "prescriptions", each specifically job-engineered to solve some individual water conditioning problem for industry. Because we feel it is so important to "tailor-make" our formulations, each of our plants actually performs the function of a giant industrial pharmacy.

The blending and shipment of our chemical formulations is, however, only one important part of our *completely-individualized* water conditioning service. Individual investigations, plant control methods, daily testing programs, periodic checkups, analyses of water samples, and regular engineering reports all combine to provide a water conditioning service that is complete in every detail.

The end result of individual attention to individual problems is obvious . . . the assurance of a plant (perhaps your own) operating at peak efficiency, free from water problems.

A 20-minute, no obligation discussion of your plant water problems with a Betz District Engineer is the best investment in time you can make. Call him in today.

W. H. & L. D. BETZ, Gillingham & Worth Streets, Philadelphia 24, Pa. In Canada: BETZ Laboratories Limited, Montreal 1.

BETZ

CONSULTANTS ON INDUSTRIAL WATER PROBLEMS

ARGUMENTS

So you don't agree with something we printed? And you want to give your views? Here's your page — shoot in a letter

Marmy checks up on the relation of speed to energy

► THE STATEMENT "fuel consumption is squared every time you double a boat's speed" (see "Marmy turns water into oil," Nov POWER) does not seem to check with Marmaduke's usual competent grasp of engineering fundamentals.

Say a boat burns a ton of coal an hour at ten knots; how much will it burn at 20 knots?

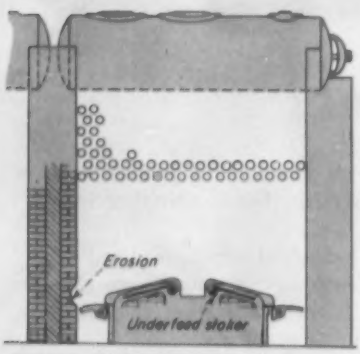
Square of 1 equals 1, so apparently the speed increase is obtained with no extra fuel consumption. Using pounds instead of tons gives even wilder results, as follows: 2000 squared equals 4,000,000, so he couldn't maintain increased speed for any length of time.

The figures are equally fantastic for burning oil. Therefore, the gag that he burned oil and not coal is no answer. But maybe he misstated the rule just for fun so hundreds of us would write in about it.

Since he is six feet four, and I am only five feet, five and a half, I trust I am writing from a good safe distance.

ANDREW SHEEHAN *Springfield, Mass.*

MARMADUKE'S NOTE: *Bilge water on squaring fuel consumption when doubling a boat's speed! As Sheehan probably knows, it's the* HORSEPOWER THAT VARIES DAMN NEAR AS THE CUBE OF THE SPEED. *If one of his friends doesn't believe it he can try swimming across the Connecticut River. Using twice as much energy as usual, he'll get across less than 1¼ times as fast. And I'll be glad to time him.*



Why was this boiler condemned?

A FEW YEARS AGO while I was in charge of some small heating plants, my boss and another engineer, who was trying to better himself, called in the Boiler Inspector and had one boiler—in a battery of two—condemned. Reason: Brick lining was eroded in the center wall of the furnace. Boiler had been inspected and OK'd about three weeks before.

Why should he condemn this boiler because lining was eroded thin? And why should lining be renewed all the way up to the tubes? It was a 250-hp Heine cross-drum boiler.

ALFRED FRENCH *Detroit, Mich.*

Comments on automatic combustion control

Edwards' controls (Nov "Arguments") are not calibrated properly. Apparently the air is cut off too soon when overpressure is experienced. But why does he have overpressure? Evidently the watch is not overly alert. Further, the grate mechanism should be thoroughly checked—it may be binding.

I recommend the following (1) Check the watch. Overpressure should not occur on any boiler. (2) Check the control calibrations, especially the air cut-back. In any control system, oil follows air. Hence, if you regulate air properly for the range (minimum to maximum), no air cut-back is necessary. (3) Check the stoker feed for irregularities.

If the combustion ratio is accurately set, burning out seems remote.

C M SCHIRMER *USS Northampton*

The automatic combustion control is a handy boiler accessory, but it is only a control. It has to be watched.

If, as Edwards states (Nov, p 142), there is a time when air shuts off and stoker continues to run, all operator has to do is push the stoker stop-start button or a disconnect switch for a short period until the situation is back to normal. But be careful stoker is not stopped too long at one time, as this will burn clips faster than a hot fuel bed with stoker running.

I know of two conditions that will burn out grates on chain drives: (1) using a slow-burning coal on a fast-moving stoker (2) burning a coal that cakes together, seals off air, causes runover.

If you avoid these two headaches and watch controls carefully, you won't have much trouble with burned grates.

ROBERT GRAEFEN *Chicago, Ill.*

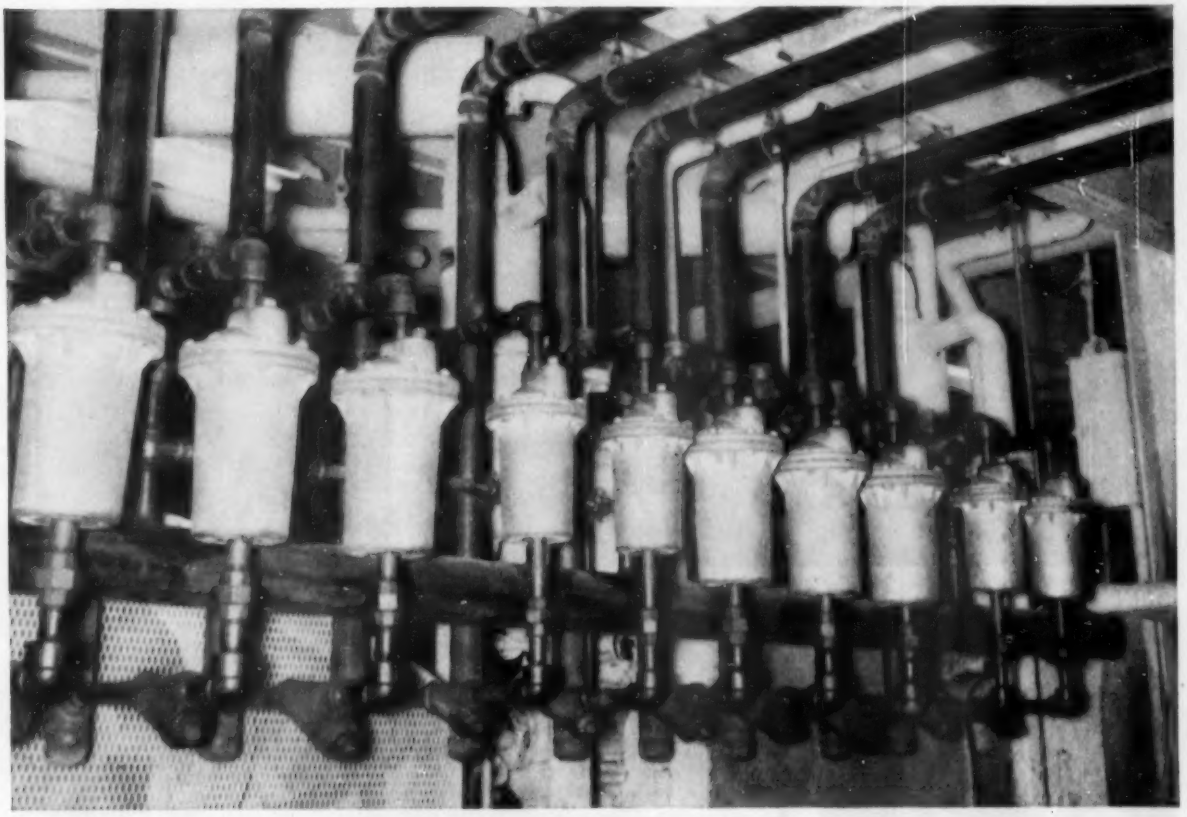
I think Edwards' automatic controls (Nov "Arguments") are the victims of circumstances.

A change in operating procedure is all he needs, assuming the controls are adjusted properly and working right.

Edwards probably has a stratification of coal on the grates in the automatically controlled boiler. Coal feed is (1) running continuously or (2) hopper is loaded, run nearly dry, and refilled to the peak. This concentrates heavy coals at the outside edge of each fill. Heavy coal burns faster and gets more air than the rest of the feed, causing the slagging or burned condition to develop.

CLYDE HOWARTER *Canton, Ill.*

(*Continued on page* 214)



Tip on Choosing Steam Traps: Run Tests with a Pyrometer

Bottom inlet-top outlet traps in six sizes, ½" to 2" connections; 950 to 20,000 lbs/hr capacity.

Side inlet-side outlet traps in five sizes, ½" to 1¼" connections; 680 to 6700 lbs/hr capacity.

Integral strainer traps in three sizes, ½" and ¾". Cost less than trap and separate strainer, save fittings and labor.

A common problem—Traps on Rogers spray driers at Rochester Dairy Company, Rochester, Minn., required frequent servicing—used up about two months of one man's time annually. And, then, within about 30 days after trap servicing, drier temperatures would be 100 degrees below steam temperature. Nobody has to put up with such trap troubles!

Take a tip from this solution!—Henry T. Maass, Building and Utility Supt., took action. He ran extensive pyrometer tests on his driers, using different makes of traps.

100° hotter!—The driers are now equipped with Armstrong inverted bucket steam traps. Temperatures correspond to steam pressure—100 degrees hotter than before. Maintenance?—negligible. Rochester carries $63.31 of Armstrong trap parts in maintenance store against $873.52 in parts for another make of traps that haven't been replaced yet.

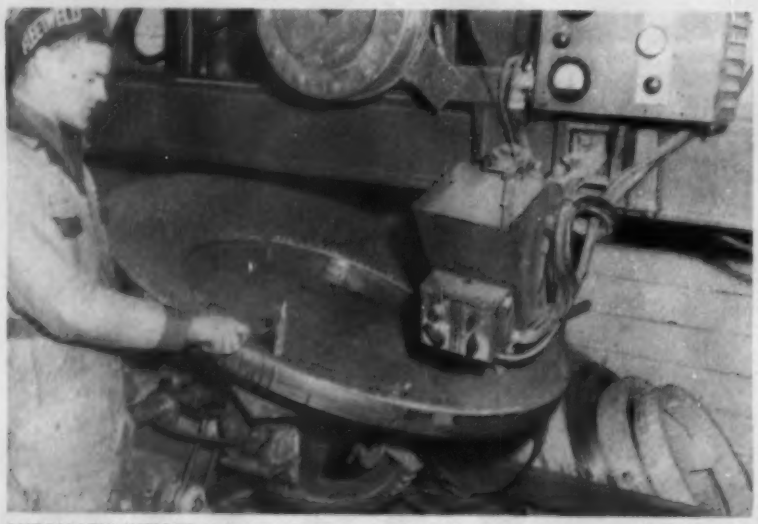
Moral—A small investment in Armstrong steam traps can make a world of difference in performance of production equipment and in cost of maintenance. Call your local Armstrong Representative, he has the products and the experience and the ability to be of real assistance.

FREE CATALOG

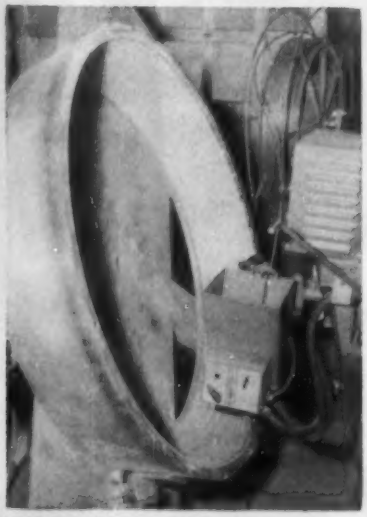
The 44-page Steam Trap Book is "the handbook of steam-trapping". Selection, installation, maintenance, capacities, data, prices, tables, charts, useful material—yours for the asking without any obligation. Also see data in Sweets or Chemical Engineering Catalog.

Armstrong Machine Works
812 Maple Street, Three Rivers, Michigan

Application Engineered
ARMSTRONG STEAM TRAPS

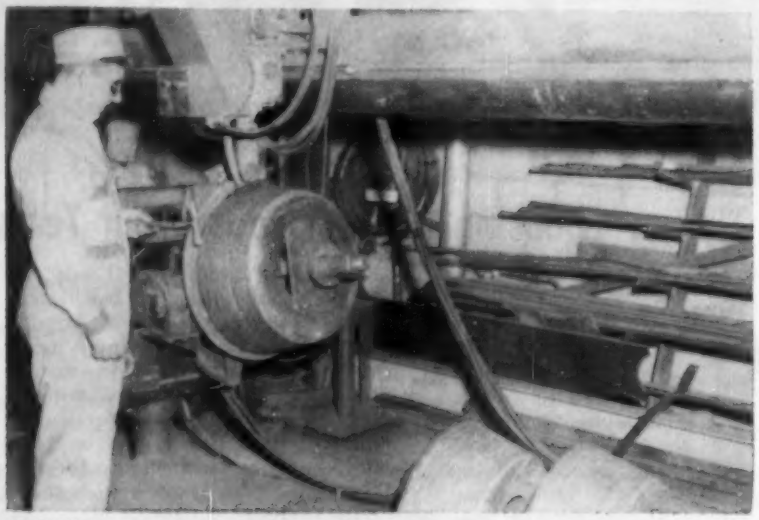


AUTOMATIC WELDER is laying down a weld bead to build up worn surface of coal-mill ring that rotates slowly as the welding head is fed transversely across ring



WORN RING of 1045 steel is next built up as ring turns automatically on axis

BUILDING UP coal-mill roll on machine that is designed for this kind of work



MACHINE can be placed in any convenient shop corner, is simple to operate because it's automatic and almost foolproof. Welding beads are high, and of uniform quality

HOW TO

hard-surface your coal-crusher rings

► COAL CRUSHERS or "mills" are popular. Crushing action here is by conical rolls rotating in steel rings. As coal produces considerable abrasive action, both rolls and rings are subject to rapid wear and have to be resurfaced or replaced from time to time.

For Raymond mills, rings used to be made from 1% carbon steel, but welding heat-cracked them. Today, rings are SAE 1045 steel, and can be given a highly wear-resistant coating by automatic arc-welding, often quadrupling their life. Machine feeds wire automatically, and agglomerated granular flux covers arc. Beads are continuous, surface is dense, needs no machining. More than one weld-metal layer can be laid.

Flux is fed automatically, keeps arc covered; operator doesn't need mask. Welding speed is about 20 inches a minute—several times faster than by hand. Flux chips off easily, there's no weld spatter.

Rolls made from chilled cast iron are also built up same way. Rolls are on positioner and turn on axis, inclined so top element of cone is parallel to horizontal track along which welding heat is fed. Work rotates at surface welding speed of 24 inches a minute.

Built-up rings and rolls machined to size cost an average of 50% as much as new ones. They have three times their life and, besides, there's less handling. —*Lincoln Electric Co, Cleveland, Ohio*

(Advertisement)

HALL INDUSTRIAL WATER REPORT

Hall Laboratories, Inc.—A Subsidiary of Hagan Corporation, Pittsburgh, Pa.

Volume 3 FEBRUARY 1955 Number 1

It Takes a Lot of Water Conditioning To Manufacture an Automobile

And the water problems in some two hundred auto manufacturing plants serviced by Hall Laboratories are almost as varied as the number of operations required to put a new automobile on the highway.

Service records of the Hall engineers tell the story:

In the Boiler House:

Automotive Hardware Plant No. 62
Report by H. A. Reda

No. 2 Boiler (over 30 years old) has been baffled as per our recommendations to reduce carry-over. In line with mechanical changes, continuous blowdown systems have been installed on all of the boilers so that a control program for regulating the rate of blowdown can be set up.

Units which had been opened reflected considerable improvement in sludge distribution. These improvements were realized not only because of mechanical changes, but also by the very close control maintained over boiler-water conditioning.

In Plant Processing:

Metal Fabricating Plant No. 83
Report by J. A. Ivancic

Processed parts of sheet aluminum came through cleaning with electrical resistance so high that welding of the finished product was difficult. Resistance amounted to hundreds of microohms on the surfaces instead of the maximum acceptable resistance of 35 microohms. Plant men suspected change in water supply might be responsible.

Working with the capable plant engineer, our process specialist Kurt Albrecht spotted other possible sources of trouble when he was called in to study the problem. In the deoxidizing bath, conditions were such that appreciable silicic acid salts could plate out on the aluminum. At the final rinse stage, acid dosage did not compensate for the wide variations in alkalinity of different water supplies. The type of wetting agent being used in this operation further contributed to the surface resistance of the finished parts. Finally, drying methods evaporated rather than removed rinse solution, leaving solids of high resistance.

Close control of deoxidizing is now being maintained by the improved methods recommended. Constant use of deionized water and elimination of acid feed (carry-over from deoxidizing now provides the correct pH of solution) minimized the pick-up of solids in the final rinse. Blasting with compressed air to remove rinse water further reduced the surface resistance of the parts. More reliable measurement of resistance has resulted from an improved method.

Plant men informed us that Kurt Albrecht got them squared away ok on their aluminum cleaning problem.

In the Condensate Return System:

Engine Plant No. 142
Report by R. R. Christian

Tank engine plant showed marked corrosion reduction during a test period feeding a maximum of 2.5 ppm. of Hagafilm. Comparative tests showed corrosion reduction of 98 percent in the boiler house lines, and 89 percent in the main manufacturing building.

In Plant Water and Cooling Systems:

Automotive Assembly Plant No. 7
Report by F. R. Duesing

Major cause of production delays in this assembly plant was frequent burning out of tips on water-cooled spot welding guns. Tips were plugging up with dense hard material, shown by lab tests to be corrosion product, calcium carbonate scale, and some asbestos dust from a neighboring plant taken into the system by way of the cooling tower.

Threshold treatment, using the new Calgon® Composition T, which allows very low phosphate reserve and a comparatively broad pH range, eliminated scale formation and corrosion. But the asbestos dust being caught in the cooling tower and so introduced into the recirculating system still plugged the welding gun tips. Filters were recommended and installed to handle only the water supplying the welding guns.

Combination of chemical and mechanical treatment has now eliminated burn-outs.

Automotive Assembly Plant No. 34
Report by L. P. Dougherty

Experience on a previous job at an assembly plant serviced by Hall engineer S. R. Osborne led the power plant engineer to start a new tank plant off right by treating well supply with glassy phosphate, and a closed cooling system with chromate.

At the new plant the treatment of well water and the recirculating system is being carried out without a hitch.

* * *

Manufacturing automobiles is the business of all these plants. Hall Laboratories' part in getting the cars on the road is to help the industry to obtain the most service from the millions of gallons of water being used in its plants.

Industrial Water Problems Require Special Handling

There are no "stock answers" to industrial water problems. For information, write, wire or call Hall Laboratories, Inc., Hagan Building, Pittsburgh 30, Pa.

Water is your industry's most important raw material. Use it wisely.

BASICS . . . *bringing engineering theory down to earth*

TOD WALDRON, *Assistant Editor*

How fuels burn - 2

Proper gas-air mixture plus enough heat gives . . .

. . . burning. These two drawings represent perfect mixing

► LAST MONTH we talked about oxidation and how burning starts—how every fuel must be a gas before it burns. So this month we start with combustion of gases. But first let me introduce a few characters who will show up from time to time in this series:

The two on the left, carbon and hydrogen, are the two basic fuel elements. And, here, they are the only fuels we need to mention. Next meet oxygen, the go-getter of combustion, and nitrogen, the free rider.

Hydrogen is normally a gas, carbon a solid. The two exist in almost innumerable combinations called hydrocarbons. Many of these compounds, like methane (CH_4), are normally gaseous and form the major part of most important fuel gases.

Combustion of gases. Suppose we have methane, drawing in upper left, and want it to burn. We need first to surround it with enough oxygen and then to raise the temperature of the mixture to the ignition temperature. Drawing shows chemically perfect air-gas mixture for one molecule of methane. A multitude of these perfect arrangements together make the perfect air-fuel mixture—both chemically and mechanically.

Air needed. From the discussion above and the two drawings, we can see that each element or compound needs a specific amount of oxygen for complete combustion. So it becomes easy to figure exactly how much oxygen we need to burn a given amount of gas, and, from this, how much air. Air and gas mixed in exact proportions needed gives perfect or theoretical mixture.

Relation between gas and air is called fuel-air ratio. It is usually expressed in terms of weight. This ratio can be figured from the chemical balance.

Ignition temperature. In our drawing, top left, we have our perfect mixture. Heat from the match supplies the other element needed for combustion.

Speaking in terms of a multitude of methane molecules in a perfect mixture: If we heat the mixture gradually, rate of chemical combination increases until reaction no longer needs heat from outside source. Practically instantaneous burning takes place. Lowest temperature at which this happens is ignition temperature. It is the temperature at which heat is generated by the reaction faster than it is lost to the surroundings.

Actual ignition temperature depends partly on surroundings. It usually refers to combustion in atmospheric air. Pressure, for one, affects ignition temperature—lower temperatures needed at high pressures.

All we have said applies equally to nonperfect mixtures, or mixtures a little leaner or a little richer than perfect. But for each gas there is a point where the mixture becomes too lean or too rich for ignition and continued burning. A flooded carburetor is a good example of too rich a mixture. The same engine misses fire if carburetor is adjusted for too lean a mixture.

So each gas has a range of mixtures that ignite, continue to burn, called flammable mixtures. Limits of range are known as limits of flammability.

JENKINS REGRIND-RENEW PLUG TYPE VALVES WITH

500 BRINELL *Armor Seat*

Armored against valve-killing close control of steam . . . and abrasion

Plug and seat ring are Jenkins JX500, a stainless chromium alloy steel made to Jenkins high strength specifications, heat-treated to 500 Brinell hardness. Seating surfaces are super-hard and mirror-smooth, offer highest resistance to galling, cutting, abrasion, and erosion . . . and "wire drawing" effects of close regulation of steam.

300 lb. 200 lb. 150 lb.
Globe and Angle

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Call your Jenkins Valve Distributor, and ask for Form 202, or write: Jenkins Bros., 100 Park Avenue, New York 17.

JENKINS VALVES

LOOK FOR THE JENKINS DIAMOND

"Bilge water on sliding resistance, damping resistance, molecular film, and all that test equipment!" said Marmy

Marmy unfouls the USS Lejeune

► POWER readers know by now that Marmaduke Surfaceblow solves perplexing engineering problems in a simple way. If he isn't moving a horse into a church steeple to straighten out a refrigeration problem, then he's taking off his pants to get to the bottom of insulation theory.

I thought he could wise me up on when to pop a safety valve—the argument that's been kicking around in POWER for some months now—so I called on him. His dingy old office above O'Houlihan's Machine Shop & Engine Works was quiet when I climbed the rickety stairs. But the crafty old genius was inside, puffing away on a rope yarn and was highly absorbed in skulduggery at his roll-top desk.

When I mentioned safety valves, he looked up for the first time and bellowed, "Bilge water on popping safety valves! I'm just doing some consulting work on a bearing problem. So I'll tell you about the time I got one of our big Navy transports to sail in time to join her convoy. With that he propped his size 16 shoes up on his desk, leaned back in his swivel chair and blasted away.

"Back in World War II, I was master mechanic at a large ship yard on the East coast. One day we got an SOS from the Navy to solve a main-shaft bearing problem on the troop transport *USS Lejeune*.

"That ship had been built by the North German Lloyd SS Line in Hamburg, Germany. As the line's flagship on the West African run she was the fastest and most modern liner in the fleet.

"Her boilers carried 1200-psi steam and she had two turbines driving twin propellers through reduction gearing. Each main drive-shaft was 151 ft long and 16 inches in diameter. Each shaft was supported by 12 roller bearings about 12 ft apart.

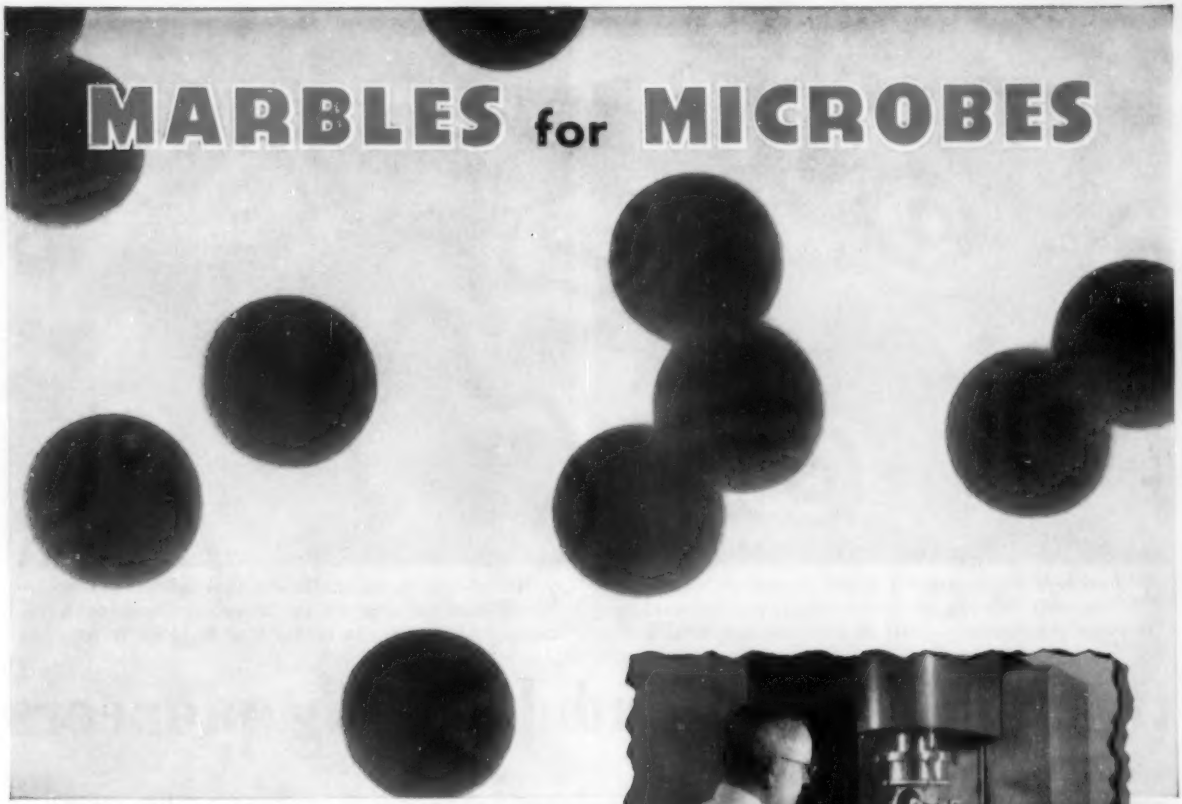
"That ship, named the *SS Windhauk* by the Germans, made her last trip as a passenger and freight ship under the Nazi flag to Rio de Janeiro, Brazil. War had been declared as she pulled into that port and the Brazilians came aboard to confiscate her as soon as she tied up—but the Germans were ready for them.

"While the Captain and his deck officers delayed the Brazilian boarding party with drinks, the engineers below got busy. They stopped the feed pumps and in a few minutes these high-pressure boiler tubes looked like so much tangled rope. They poured liquid cement into the turbines and reduction gear casings. One Nazi got busy with an acetylene torch and burned a groove into the races of each of the 24 shaft alley bearings. By the time the Brazilians staggered below, that proud ship was ready for the boneyard.

"Our Navy bought her and sent a crew of motor-machinist-mates down there and two large diesel engines. Months later, she was sailed up to Norfolk, Va. with that jury rig. How our boys got her through the submarine wolf packs at only four knots is another story.

(*Continued on page* 196)

MARBLES for MICROBES



Above—100,000X enlargement of latex spheres used to calibrate electron microscope in Nalco Laboratories. Actual diameter of spheres is 0.25 microns—.00000975 inches! *Right*—Inserting specimen holder in vacuum chamber of Nalco electron microscope.

. . . How they assist research toward better Water Treatment

PERHAPS even too small to make good marbles for microbes, these tiny spheres help Nalco Scientists in their investigations of the microscopic realms of matter only recently made visible to the human eye by the electron microscope.

Use of the electron microscope in water treatment research is significant because it typifies the continuing efforts of the entire Nalco organization to keep the Nalco System representative of the first and best in all phases of modern industrial water treatment.

If you are not already participating in the economy and efficiency of the Nalco System in your plant, write for details on real water treatment security today.

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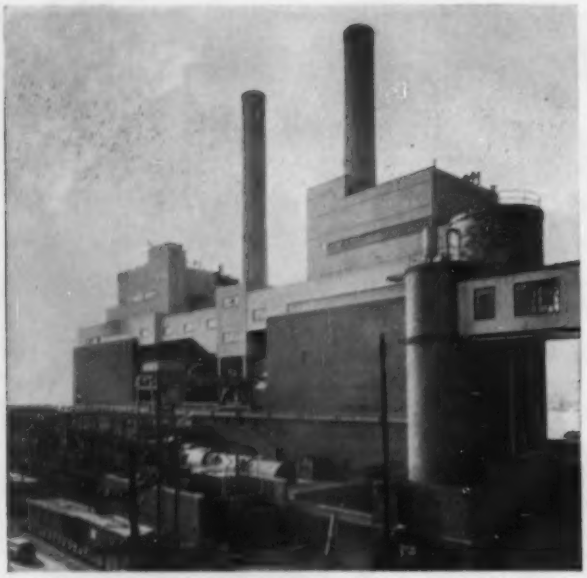
THE *Nalco*®
SYSTEM . . . Serving Industry through Practical Applied Science

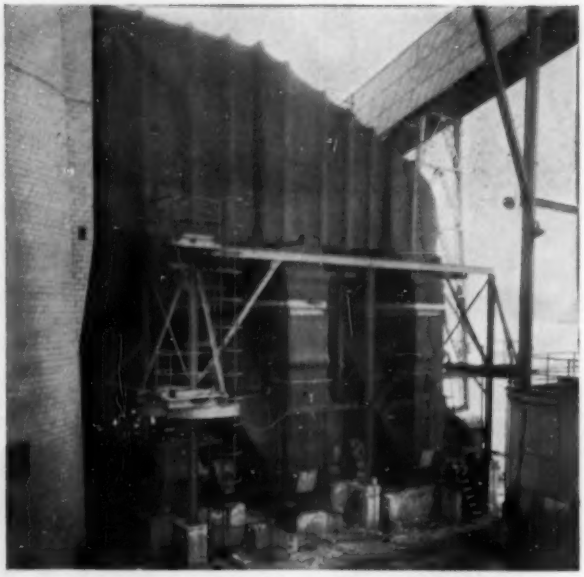
Nalco WATER TECHS

New reprint of A.S.M.E. Paper No. 52-A-30: *Experimental Studies of Boiler Tube Metal Temperatures: Effect of Heat Transfer Rate and Deposit Thickness*, gives technical data on high-heat-transfer-rate effects (140,000 to 300,000 Btu/sq. ft./hr.) at pressures from 250 to 2500 p.s.i. 16 pages, with tables and diagrams. Author: C. Jacklin, Director, Engineering Research, National Aluminate Corporation.

Your Copy Free Upon Request

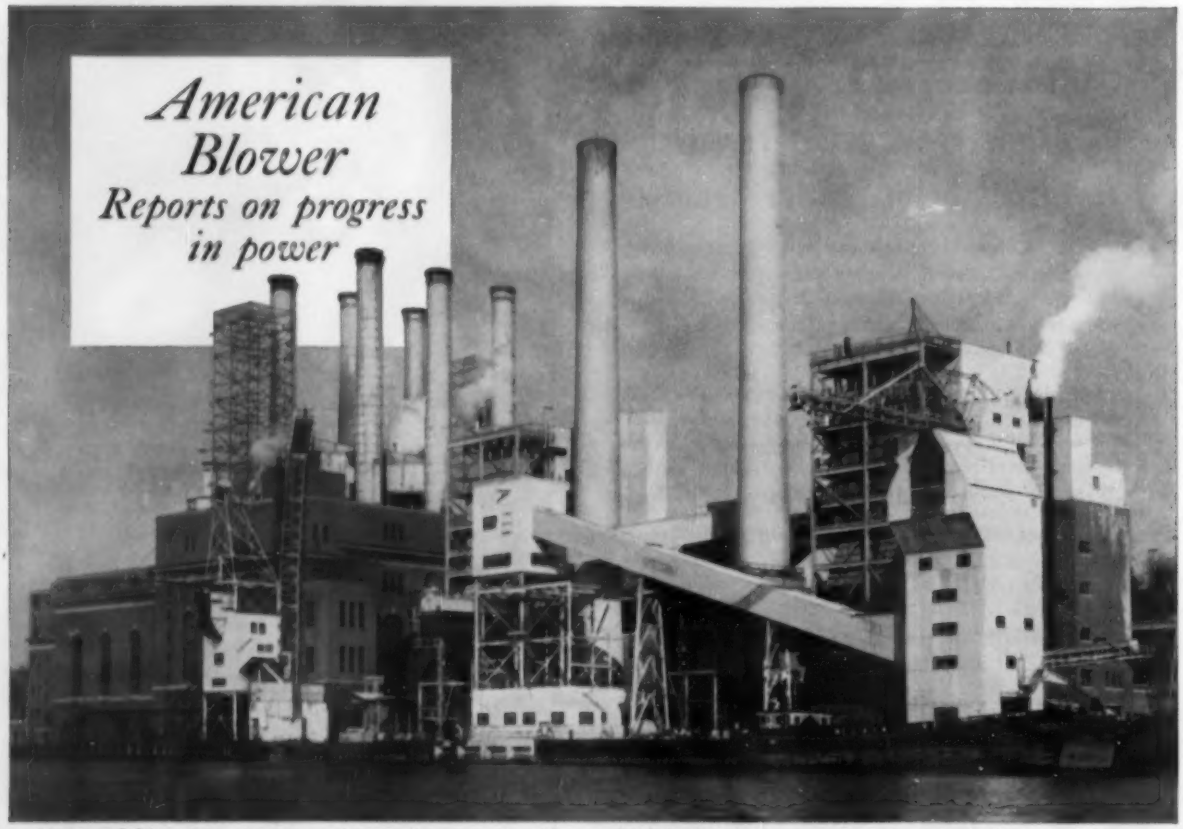


1. Two new units at Long Island Lighting's Glenwood Plant add 220 Mw to plant's capacity. Note outdoor turbines (foreground) — first in northeast area of U.S.

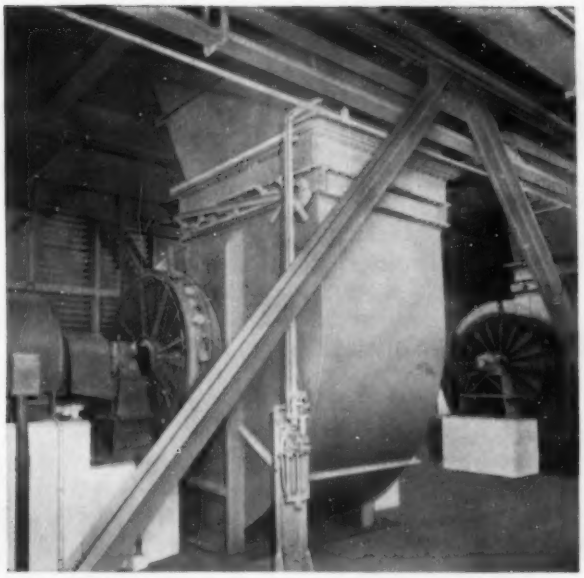


2. These two American Blower Induced Draft Fans are installed on unit #5 at Glenwood Plant. Each has capacity of 197,000 cfm @ 275°F @ 17.10 sp, @ 703 rpm.

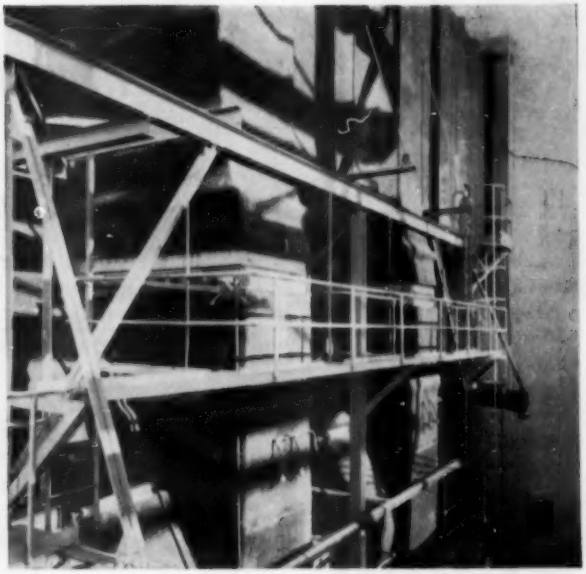
Long Island Lighting pioneers



Glenwood Plant uses American Blower Fans on six older units and new outdoor-type units (right). Long Island Lighting's other generating plants include: Port Jefferson, Far Rockaway and Edward F. Barrett stations.



3. American Blower Forced Draft Fans on Glenwood's #4 unit are each rated @ 135,000 cfm @ 100°F @ 12.75 sp, @ 875 rpm.



4. These American Blower Induced Draft Fans are installed on Glenwood's #4 unit. Each fan is rated at 197,000 cfm @ 275°F @ 17.10 sp, @ 703 rpm.

use of outdoor-type units in Northeast; operations reflect design progress!

Leading power company shows *progress in power* with new outdoor construction, reheat cycle and American Blower Fans

SINCE THE second world war, the Long Island Lighting Company has spent millions on expansion — over $150,000,000 on electrical facilities alone. Operating efficiencies have gone up.

The use of the reheat cycle and high steam pressures and temperatures have cut fuel costs. New outdoor-type generating units permitted greater flexibility and saved in construction costs. However, these new units, using American Blower Forced and Induced Draft Fans, have provided more than flexibility and savings: they are also free from objectionable noise.

When it comes to air handling equipment, leading power and industrial plants prefer American Blower equipment for its quiet, dependable operation, for indoor as well as outdoor-type installations.

Whether *your* modernization or expansion plans call for Mechanical Draft Fans, Fly Ash Precipitators, Dust Collectors, Heavy Duty Steam Coils or Gyrol Fluid Drives for boiler feed pump and fan control — profit by discussing your needs with an experienced American Blower representative. Call your American Blower Branch Office, today, or write us direct.

AMERICAN BLOWER CORPORATION, DETROIT 32, MICHIGAN
CANADIAN SIROCCO COMPANY, LTD., WINDSOR, ONTARIO
Division of American Radiator & Standard Sanitary Corporation

AMERICAN BLOWER

Serving home and industry: AMERICAN-STANDARD • AMERICAN BLOWER • CHURCH SEATS & WALL TILE • DETROIT CONTROLS • KEWANEE BOILERS • ROSS EXCHANGERS • SUNBEAM AIR CONDITIONERS

Reader service section

Start with these quick samples . . .

That's the size of it . . .

12-story-high boiler at Redondo, largest of its type west of the Mississippi, has special structural design to guard against earthquake forces. Reports from the Field gives the dope on this installation, which brings Southern California Edison Co's capacity to 1,144,500 kw. . . . . p 158

No room for leakage . . .

in today's canned-motor pumps, which move fluids in hermetically sealed systems. A sampling of design and operating data, plus directions for obtaining your complete report, in Technical Briefs, starting on. . . . . p 160

Keep it clean . . .

that's the secret of long, troublefree life for coal valves. Stainless-steel self-cleaning pinions and special ladder racks do the job in Stock Equipment Co designs described in Plant Equipment News, plus a round-up of new problem-solving products. . . . . p 164

'Move it over, brother' . . .

and for the best way consult bulletin No. 16 in the Free Literature columns. To obtain this publication, or any of the more than half-hundred listed, use convenient postcards . . . . . p 173

Lazing in the tropics . . .

is the ideal way to rout everyday cares, climb out of that rut. Or so says George Edwards in this month's Scrapbook, proving his point with a photo. For advice, odd bits of fact, salty philosophy, turn to . . . . . p 176

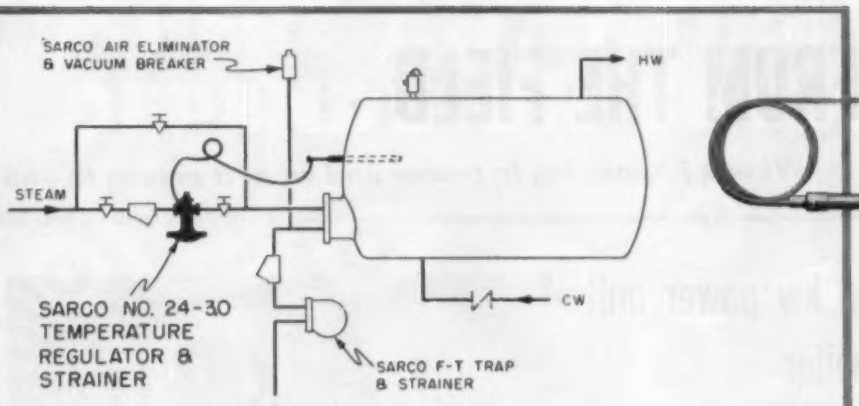
String on your finger . . .

means we'll see you at ASME's first International Congress on Air Pollution, Hotel Statler, New York, March 1, 2. Calendar of Events. . . . . p 240

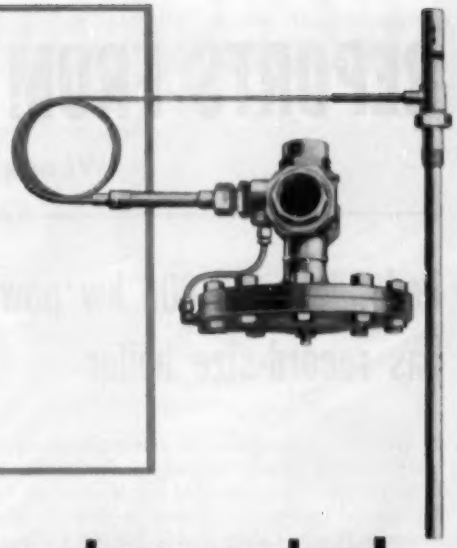
Among 100 best . . .

technical books of 1954 – that's where the Library Journal ranks "Diesel and High-Compression Gas Engines – Fundamentals", by Edgar J Kates. Readers of Ed's hard-hitting articles in POWER will agree with this rating, want the book, particularly for first-in-print material on new types of gas engines. This and other reviews in Engineer's Bookshelf. . . . . p 247

For other timely ideas, see following service pages ▶



Typical hook-up of Sarco Type 24-30 Temperature Regulator



HOT WATER...in your storage tank

...when you want it...*and at minimum cost!*

That's the performance you get when this Sarco Temperature Regulator stands guard on your water heater.

With fuel representing about 50% of your total direct power costs, it's important that you *get hot water at lowest cost per wash.*

Here's how the Sarco 24-30 Temperature Regulator does the job:

NO OVERHEATING – during periods of no draw-off. The single seated valve shuts tight, prevents creeping of temperature.

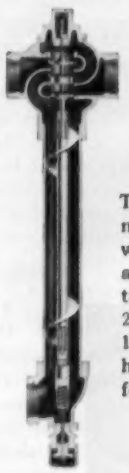
LOW INSTALLATION COST – the T R 24-30 is self-contained and self-operated, no need to install compressed air or electric lines.

CLOSE TEMPERATURE CONTROL – thermostat actuates internal pilot valve which immediately opens or closes main valve.

LOW-MAINTENANCE PACKLESS SEALS – trouble-free design eliminates stuffing boxes, no repacking, no sticking or leakage of exposed valve stems.

WIDE RANGE OF ADJUSTMENT—you can adjust this temperature regulator 25° higher or lower than the temperature setting.

So, if you're not satisfied with your hot water service, call your local Sarco representative or write for Bulletin 600. Sarco Company, Inc., Empire State Bldg., New York 1, N. Y.



Need Tempered Water ?

This Sarco Water Blender automatically mixes hot and cold water, delivers blended water at any desired temperature. Factory set for any temperature to 200° F., is easily adjusted to 15° F. lower and up to 40° F. higher than factory setting. Ask for Bulletin 800.

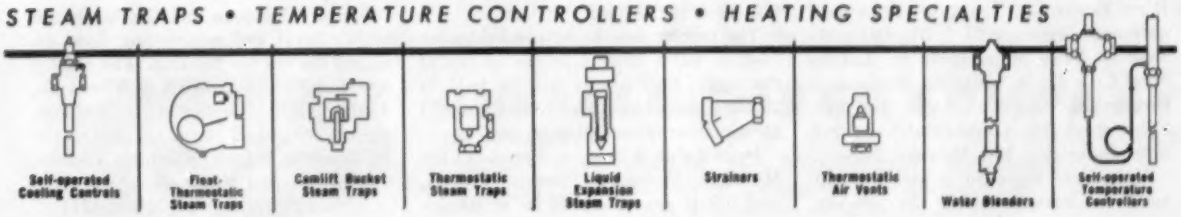
SARCO

SAVES STEAM

improves product quality and output

2046-B

STEAM TRAPS • TEMPERATURE CONTROLLERS • HEATING SPECIALTIES

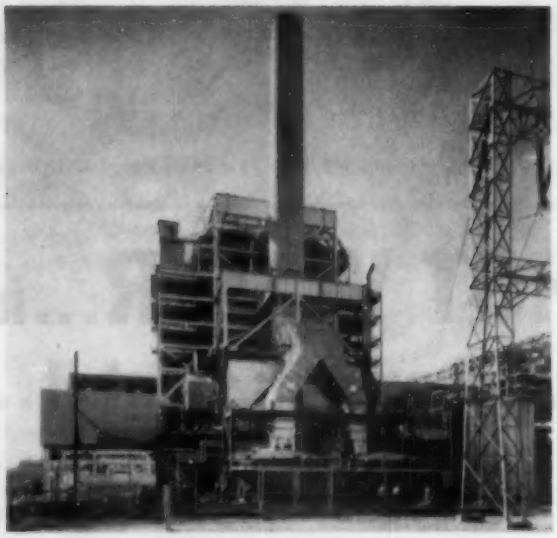


REPORTS FROM THE FIELD

What's happening in power and what it means to you

For Calendar of Events see page 240

Redondo's 160,000 kw power unit has record-size boiler



► THE BIGGEST steam electric power generating unit of Southern California Edison Company, including the largest boiler of its type in service west of the Mississippi, has gone into commercial operation. Located at Redondo Steam Station, Redondo Beach, Calif, it adds 160,000 kw capacity to the Edison system. This brings combined Redondo Steam Station to 448,000 kw capacity and total Edison steam plants to 1,144,500 kw. The unit was designed and constructed by Stone & Webster Engineering Corp in collaboration with Edison Company engineers.

The addition is the first half of a new base load plant built adjacent to the existing four unit station. Whereas the earlier station was designed for operation throughout a wide and variable load range, the new unit was designed specifically for continuous full load operation at maximum efficiency. Each kilowatt hour is produced with only one-half pound of fuel oil. This is possible primarily through high cycle pressures and temperatures, 1800 psi, 1000 F and reheat to 1000 F.

Unusual station feature is the new boiler that towers as high as a twelve-story building. This height is a particular problem in earthquake country, such as Southern California. Special attention was given to resistance to horizontal forces within a structure, such as develop during quakes. As a result, supporting steel for the boiler is exceptionally rugged.

Unit is supplied with sea water flow for condenser cooling. Two 12-ft outside diameter conduits extend 2000 ft into the Pacific. Water is drawn and returned at velocities approaching 5 ft per second. Low resistance to flow is important in handling such large volumes. Hence, great care was taken to keep the development of marine growth to a minimum.

Largest heads spun will test giant penstocks

► THE LARGEST HEADS ever spun will be used to test penstocks for the Littleton, N. H. hydro development of Connecticut River Power Co. The units, to be used only once, measure 21 ft 8½ in. in diameter. They were spun on Lukens Steel Co's 276-in. spinning machine in Coatesville, Pa. for Walsh Holyoke, Fabricators Div, Continental Copper & Steel Industries, Inc, Holyoke, Mass.

Units were flame-cut in half for shipment and reassembled at the job site.

AEC approves 1-megawatt reactor for U of Michigan

► UNIVERSITY OF MICHIGAN has final approval from the Atomic Energy Commission to proceed with construction of a one-megawatt nuclear reactor and a building to house it. Financing will be by a $1-million grant from Ford Motor Company Fund, made to the University's Phoenix Project.

The windowless, three-story structure (an addition to the north end of Phoenix Memorial Laboratory now being built) will be 40-ft high, 70-ft sq and have concrete walls a foot thick. It will house a 40,000-gal water tank. This 26-ft tank will have high density concrete walls 6-ft thick at the base.

The reactor will be suspended under 20-ft of water from a bridge at top of the tank. Fuel supply will be held in 20 aluminum cans, each containing 18 aluminum-uranium alloy strips.

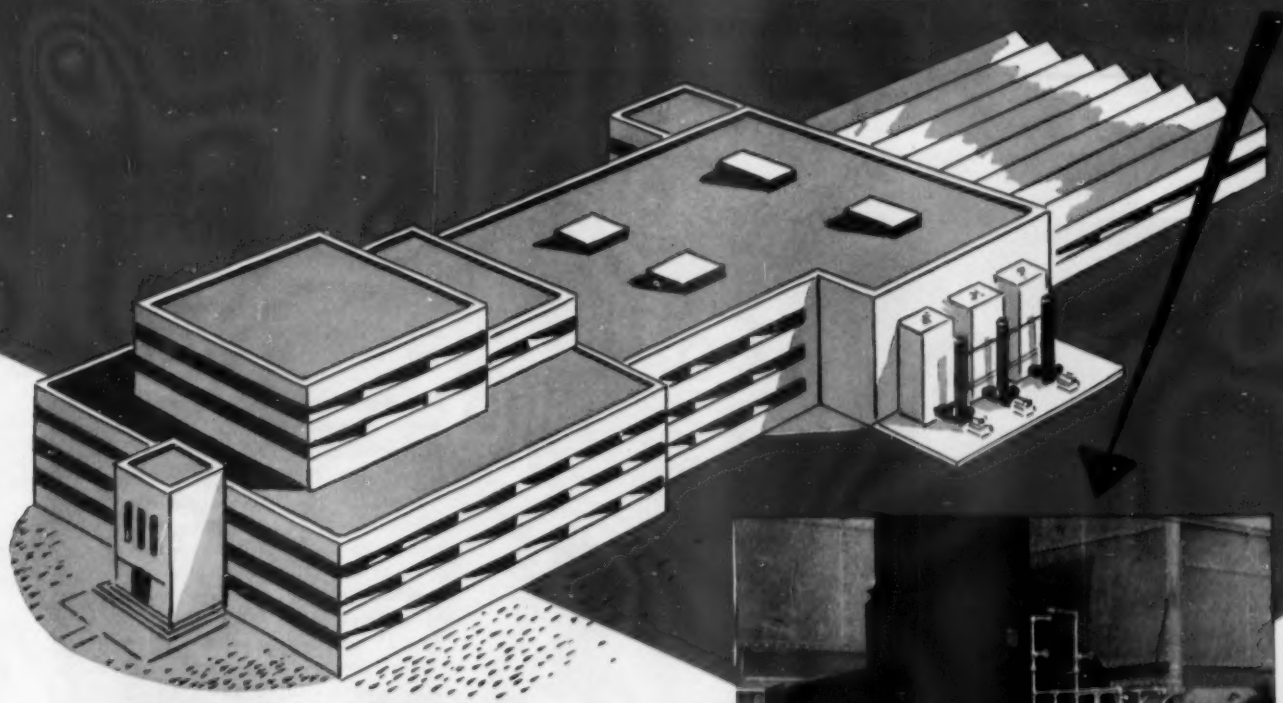
Dean Ralph A Sawyer, director of the Michigan Memorial Phoenix Project, said initial operation will be at 100-kw average power over eight hours with peak of 1000 kw. This will provide the most intense source of neutrons and gamma rays in operation by a non-governmental agency. It will be open to scientific and industrial research on an unclassified basis.

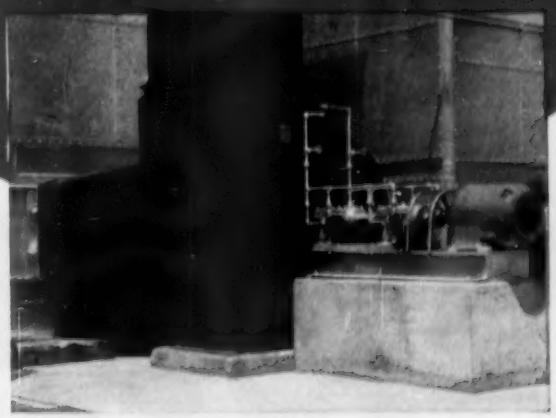
According to Sawyer, completion of the reactor will give the University "the most complete and balanced set of intense-radiation sources now available: the reactor and ten-kilocurie cobalt source of the Phoenix Project, and the synchrotron and cyclotron of the physics department."

Smith, Hinchman and Grylls, Detroit architectural and engineering firm, designed the reactor housing. The reactor was designed by Babcock & Wilcox Co, Akron, Ohio. Lawrence C Widdoes, project engineer, working under the University's reactor planning committee, coordinated the project.

(*More Power News on Page* 234)

WHERE AN ENTIRE PLANT DEPENDS ON THESE FANS





"Buffalo" Induced Draft Fan in outdoor installation

BE SURE THEY'RE "Buffalo" THE DRAFT FANS WITH THE "Q" FACTOR*

The draft fan literally supplies the "breath of life" to the plant . . . or, in the case of utility stations, to entire communities. It's an understatement to say that draft-fan timeouts are costly, and that the most durable and easily serviced fan is the most economical one.

This is why "Buffalo" Draft Fans are saving money in so many installations. They're husky . . . built up in the places where it counts. Rotor blades, rotor plates and housings are extra heavy and rigid.

Bearings and shafts are oversize. In "Buffalo" Induced Draft Fans, removable scroll liners and replaceable welded-on wearing strips protect housings and blades. Small wonder that many "Buffalo" Draft Fans are still going strong after many years on the job.

Write for Bulletin 3750 and see why "Buffalo" is your safest choice for the vital draft job.

**The "Q" Factor — the built-in Quality which provides trouble-free satisfaction and long life.*

"Buffalo"

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PUBLISHERS OF "FAN ENGINEERING" HANDBOOK

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TECHNICAL BRIEFS

Latest engineering developments for busy power men

15 Digests for you on:
PUMPS
STEAM PLANTS
POWER DISTRIBUTION
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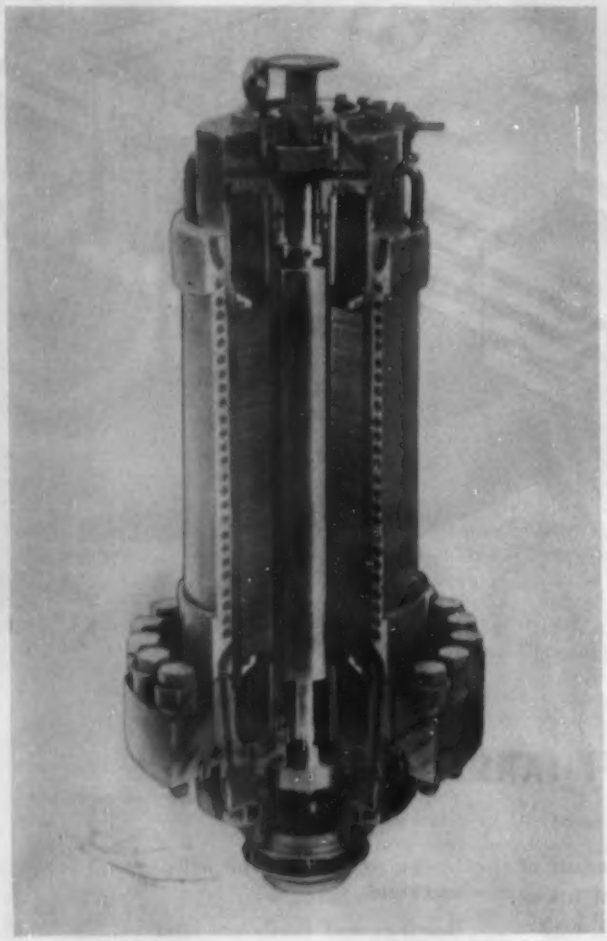

Canned-motor pumps—an answer to sealless handling of liquids on many industrial jobs

Pumping in hermetically sealed systems. *By B Cametti, Atomic Equipment Dept, Westinghouse Electric Corp.*

Although the basic principle of canned-motor pumps has been in use for years, many earlier applications required relatively small amounts of power. Since the advent of atomic power the problem of transferring energy by pumping large quantities of fluids in hermetically sealed systems has imposed greater demands on this type of pump.

The pump shown is used to circulate liquid through a reactor, to a suitable steam-generating unit, where heat energy is removed and used to drive a conventional steam turbine.

Allowable leakage tolerances are substantially zero. By enclosing entire motor and pump assembly in one hermetically sealed housing, the conventional type shaft seals have been eliminated.

To date, several sizes of units have been developed having capacities from 30 gpm and 30 psi to 4000 gpm and 100 psi. Operating time on existing units varies from as much as 20,000 hrs on smaller sizes to 10,000 hrs on larger sizes. *ASME paper no. 54-A-119.*

Design and operation of small canned-motor pumps. *By A J Mei, Atomic Equipment Dept, Westinghouse Electric Corporation.*

During development and manufacture of small canned-motor pumps in various ratings up to 25 hp, every effort was made to use standard commercial practice and materials, where acceptable. Many times slight modifications of commercial practice were required, but several new techniques and processes had to be developed and tried. Many relatively new materials were employed.

Material problems involved use of carbides, precipitation-hardening stainless steels (18-8W and 17-4 PH), age-hardened Inconel X and W, and the compatability of materials in contact while immersed in moderate- and high-temperature water.

In general, small canned-motor pumps present a well diversified assortment of problems in design, manufacture and operation. As unit size decreases, each individual component increases in importance and manufacture of bearings, electrical winding and rotors becomes harder. *ASME paper no. 54-A-120.*

On the mechanism of cavitation damage. *By M S Plesset and A T Ellis, California Institute of Technology.*

This paper describes a new method for producing cavitation damage in the laboratory. The test specimen has no mechanical accelerations applied to it. This is in contrast with the conventional magnetostriction device.

Alternating pressures are generated in the water over the specimen by exciting a resonance in the "water cavity." By this means effects of cavitation have been studied for a variety of materials.

Results of these studies and X-ray analyses of specimens shows that plastic deformation occurs. Damage results

(*Continued on page* 162)

Meet the man you can call with confidence to solve your thermal insulation problems

To insulate outdoor tanks with complete weather protection, these skilled J-M applicators follow a specification developed by Johns-Manville. Here they are fastening J-M Asbestocite* Sheets over J-M Zerolite* Insulation. J-M 85% Magnesia Insulation is also widely used for this type of equipment

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"Insulation is no better than the man who applies it." Today, with rising fuel and maintenance costs, it is especially important to place your insulation job in skilled hands. The scientific application of J-M quality insulations by J-M Insulation Contractors will assure you of the maximum return on your insulation investment for years to come. Moreover, you get undivided responsibility for *all* your insulation requirements.

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2. You get dependable engineering—For 95 years Johns-Manville has been accumulating insulation engineering experience. J-M Insulation Engineers are called upon to solve insulation problems of every type and magnitude, in every industry. Since your J-M Insulation Contractor works closely with J-M Insulation Engineers, he brings to *every* job a high degree of training, skill and experience.

3. You get dependable application—Johns-Manville has set up a nationwide organization of J-M Insulation Contractors to serve you. These Contractors maintain staffs of insulation engineers as well as skilled mechanics thoroughly trained in J-M's proved application methods. You can have absolute confidence in their ability to apply J-M insulations correctly for trouble-free performance.

For further information and the name of your J-M Insulation Contractor, write Johns-Manville, Box 60, New York 16, N. Y. In Canada, 199 Bay St., Toronto 1, Ont.

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MATERIALS · ENGINEERING · APPLICATION

More TECHNICAL BRIEFS

Begins on page 160

from cold-working of material, leading to fatigue and failure. A variety of materials have been exposed to intense cavitation for extended periods to secure a relative determination of their resistence.

Roughly speaking, it is found that hard materials of high tensile strength are the most resistant to damage. While this survey is far from complete, it has been found that of materials tested titanium 150-A and tungsten are most resistant to damage. *ASME paper no. 54-A-76.*

Recent investigations of the mechanics of cavitation and cavitation damage. *By R T Knapp, California Institute of Technology.*

Fixed-type cavitation appears to be one of the most prevalent forms in flowing liquids. Idealized concept of this form includes no mechanism for producing damage. Study of the real phenomenon shows that a multitude of small cavities sweep along interface of the fixed cavity and collapse in the downstream stagnation zone. So mechanism of damage is similar to that for the simpler traveling type.

Much significant information about type and intensity of cavitation attack can be derived from the pitting pattern on soft metallic specimens. One surprising fact is the relatively low pitting rate. At 90 fps, which is well above lower limit for cavitation damage of annealed aluminum, a given point on the surface is hit only once every 100 min. This leads to the tentative conclusion that damage produced by fixed-type cavitation is caused by relatively infrequent, high-intensity blows that either remove particles of material at each blow or by early fatigue. *ASME paper no. 54-A-106.*

Cavitation - pitting by instantaneous chemical action from impacts. *By Irving Taylor, The Lummus Company.*

The author of this paper contends that certain extremely reactive unstable substances are produced locally in water and some other liquids, at the instant of final cavity collapse, by cavitational impacts. These substances complete subsequent chemical reactions in a few millionths of a second.

They may react with each other or with the liquid itself, and disappear by reforming into the stable liquid. Those that are very close to a solid wall at the instant of their creation, however, can just as well react chemically with the solid. These reactions occur so quickly that even in a very fast-flowing liquid, evidence (pitting) may be localized within an inch downstream of main impact point.

Since the paper represents an idea rather than new experimental data, conclusions are stated in the form of contentions. Analyses of data on which these contentions are based are also presented. *ASME paper no. 54-A-109.*

Steam plants

Lower flue - gas exit temperatures through removal of the solids ahead of the air preheater. *By A J Tigges, Jackson & Moreland, and Hilmer Karlsson, The Air Preheater Corporation.*

This paper is a philosophical discussion of flue gases, stressing the important part played by the "extreme fine" solids in the flue gas. These fines are considered one of the major causes of low-temperature problems in the boiler. They cause visible smoke and therefore are believed to contribute to the dangers of smog.

Methods for removing fines in a high-temperature zone are discussed. Results obtained from experimental work for removing fines at high temperature and high velocity with high collecting efficiency are given.

The work described seems to indicate that there are some real possibilities toward a definite improvement in some of the vexing problems of flue gas—atmospheric pollution by dust, air preheater deposits and corrosion. Further, the possibility of operating the air preheater at lower gas exit temperatures with clean flue gas provides increased fuel economy. This offsets possible higher cost of removing solids in high-temperature zones. *ASME paper no. 54-A-247.*

Design aspects of an electrostatic precipitator for the collection of small solids ahead of the air heater. *By H Klemperer, The Air Preheater Corporation and J E Sayers, James Howden & Company, Ltd.*

This novel electrostatic precipitator operates in the 500- to 700-F temperature range at a gas velocity of 40 fps. It consists of 12 independent sectors, arranged in rotary symmetry.

A stream of cleaning gas continuously moves from one sector to the other to carry deposited dust into a secondary cyclone-type collector. Each sector is connected to an individual power supply, controlled on the primary side by a system of saturable reactors.

Design viewpoints are given that lead to the system described. A commercially sized test plant is described. Precipitator efficiency is of the order of 95%. *ASME paper no. 54-A-248.*

Some factors affecting flyash collector performance on large pulverized-fuel-fired boilers. *By Carl R Flodin and Harold H Haaland, Precipitation Div, Western Precipitation Corporation.*

For many years collection of flyash from pulverized-fuel-fired boilers was a relatively simple problem from the collector manufacturers' point of view. Efficiency demands were not great, with 80 to 90% meeting most of the collection requirements.

Characteristics of ash encountered on the large majority of units were such that either high-efficiency cyclonic collectors or electrostatic precipitators could satisfactorily meet the requirements. Pulverized-fuel flyash ordinarily was of such a character that precipitators of one-half to one-fourth the size regularly used in cement and metallurgical operations for equivalent gas volumes and efficiencies were successful.

At present, with demand for very high efficiencies, low stack emissions, and numerous changes in steam-generating unit design, the picture is apparently changing. It has become necessary to regard collection equipment as a necessary auxiliary of the furnace and to obtain peak performance at all times. This is occurring at the same time that design requirements for the station appear to be working against the collector.

This paper brings out some of the major factors in operation and design that must be considered in any over-all evaluation of collection problems, and raises an appreciation of their importance in the minds of responsible persons. Some of these factors pertain to high-efficiency cyclonic collectors, others pertain to Cottrell electrical precipitators, and most are common to both. *ASME paper no. 54-A-212.*

Drum internals and high-pressure boiler design. *By E M Powell and H A Grabowski, Combustion Engineering, Inc.*

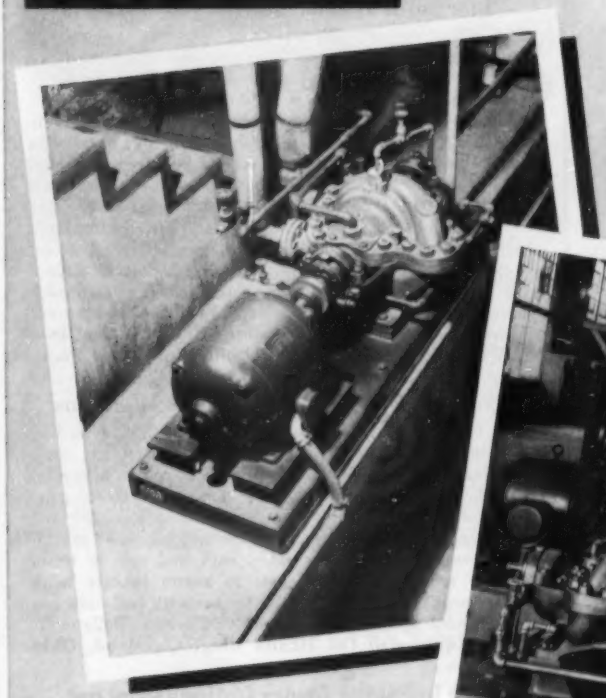
Drum internals are devices used to separate water from steam and to direct flow of water and steam in a manner to obtain an optimum distribution of

(*Continued on page* 218)

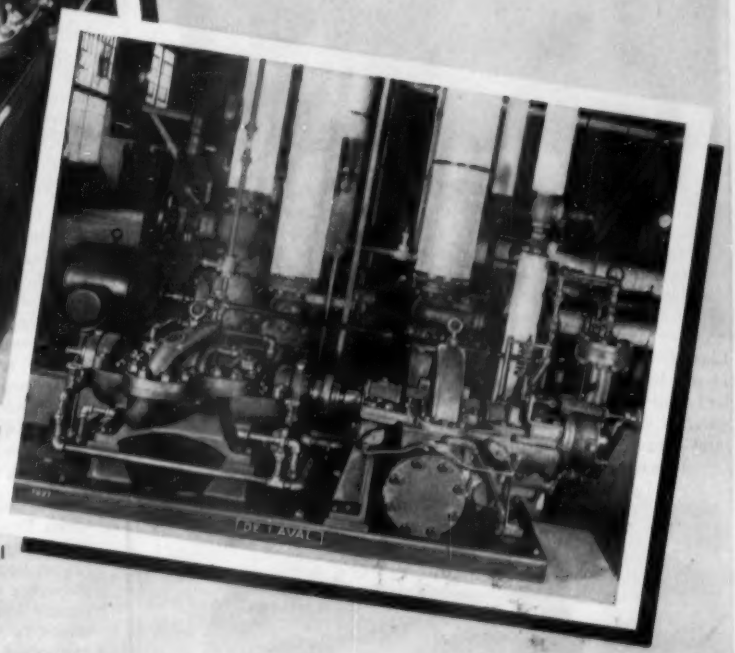
Directions for ordering papers on p 226

DE LAVAL
TWO-STAGE HORIZONTAL PUMPS

for dependable boiler feed service in institutions . . . industrial plants



Institutions can't afford shutdowns. In this hospital installation a motor-driven 21S boiler feed pump provides year-in, year-out dependability. It delivers 70 gpm of 240° water at 420 ft. head.



Industrial plants, too, choose reliable De Laval pumps for boiler feed service. This De Laval unit, driven by a De Laval turbine, delivers 160 gpm of 215° water at 520 ft. head.

There are good reasons why De Laval 21S-2KS two-stage horizontal split case pumps give long, economical boiler feed service. They are designed with • back-to-back impellers for balanced hydraulic thrust • easily replaceable threaded impeller wearing rings • long life labyrinth case rings • ring oiled ball bearings — plus ten other important design features.

These De Laval pumps are available in sizes from 2" to 8" discharge, for capacities from 75 to 3,000 gpm and heads to 750 ft.

Write for Bulletin 1501 giving complete data.

DE LAVAL *Boiler Feed Pumps*

DE LAVAL STEAM TURBINE COMPANY

815 Nottingham Way, Trenton 2, New Jersey

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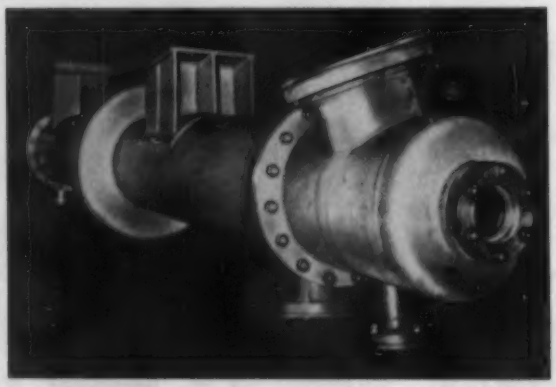
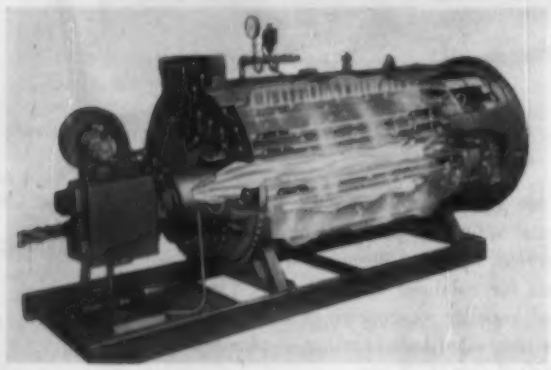


Heat exchangers for pressures over 150 psi

201 • Semi-standard units, for pressures of 150 psi and higher, are available with many optional features. They may be specified in stainless steel, carbon steel or other alloys, with or without an expansion joint. Nozzles may be any size or in any location required by the installation. Thickness of tube sheets is ⅞ in. and up; thickness of bonnets and channels is 3/16 in.

Construction details meet ASME Code specifications and TEMA Class C standards. Standard shell diameters are 5, 6, 8, 10, 12, 14 and 16 in., with various lengths in each size. Construction may be 1, 2 or 4 pass, and tube diameters may be ⅝, ¾ or 1 in. Small stainless steel nozzles are schedule 40 stub ends, with ASA lap-joint flanges. Complete details on request to manufacturer.

Downingtown Iron Works, Inc, Downingtown, Pa.



Package boiler has rating of 15 hp

202 • A 15-hp Scotch boiler has been added to company's line of automatic *Steamboilerplants*, ranging from 12 to 125 hp. Completely assembled, it is ready for immediate operation after electricity, steam, water, fuel and stack are connected. Equipment includes burners, blower, combustion safeguards, and necessary valves and controls. The model is available for burning gas only, oil only, or gas and light oil.

Design and construction equals or exceeds requirements of ASME Code and *Code of Ethics* of Industrial Gas Equipment Division of GAMA. Unit is 160-in. long, 44-in. wide, 61-in. high.

Eclipse Fuel Engineering Co, Buchanan St, Rockford, Ill.

Electronic system controls power output

209 • System uses self-correcting electronic controls to regulate a power plant's output and frequency in accordance with electrical demand changes. It is said to be faster acting, more accurate than conventional mechanical systems, and less complicated and expensive than earlier electronic models. Signals to each station require only one channel as contrasted to multiple channels needed for present systems.

Individual servo units supervise three different methods of control. Signals, or "pulses," characterizing load swing are telemetered to these servo units. They electronically compare signals with standard operating levels. If a discrepancy is detected they initiate control action, by adjusting turbine governors, to bring system load and frequency back to normal. Full particulars on request to manufacturer.

Minneapolis-Honeywell Regulator Co, Industrial Div, Wayne & Windrim Aves, Philadelphia 44, Pa.

Coal valve has self-cleaning racks, pinions

210 • Outstanding feature of these coal valves, according to manufacturer, are the ladder racks and stainless steel, self-cleaning pinions. Double ladder racks consist of several coined, rectangular, tapered holes along each side of gate. They have no root portion; hence present no place for coal build up. Self-cleaning pinions have multiple faces providing increased clearance to sides, back and root of teeth. Pinions are located above gate to assure positive tooth engagement. Designed primarily for use with coal, unit can be applied to many materials in other industries. Bulletin 97.

Stock Equipment Co, Hanna Bldg, Cleveland, Ohio

Pipe line water heater for industrial use

211 • Unit is designed for direct connection to water or steam lines. It will produce water temperature rise up to 100 F with water at 100 psig and steam at 100 psig. In the heater, liquid under pressure attains a high velocity passing through a nozzle. Steam enters through a series of slanting nozzles in combining tube. Mixing of liquid and steam occurs in venturi throat, where liquid absorbs all of heat of the steam. Hot liquid is then discharged into tank or through a piping system. For greater temperature rise, two heaters may be used in a series. Request bulletin 3-A.

Schutte and Koerting Company, Dept JN, Cornwells Heights, Bucks County, Pennsylvania

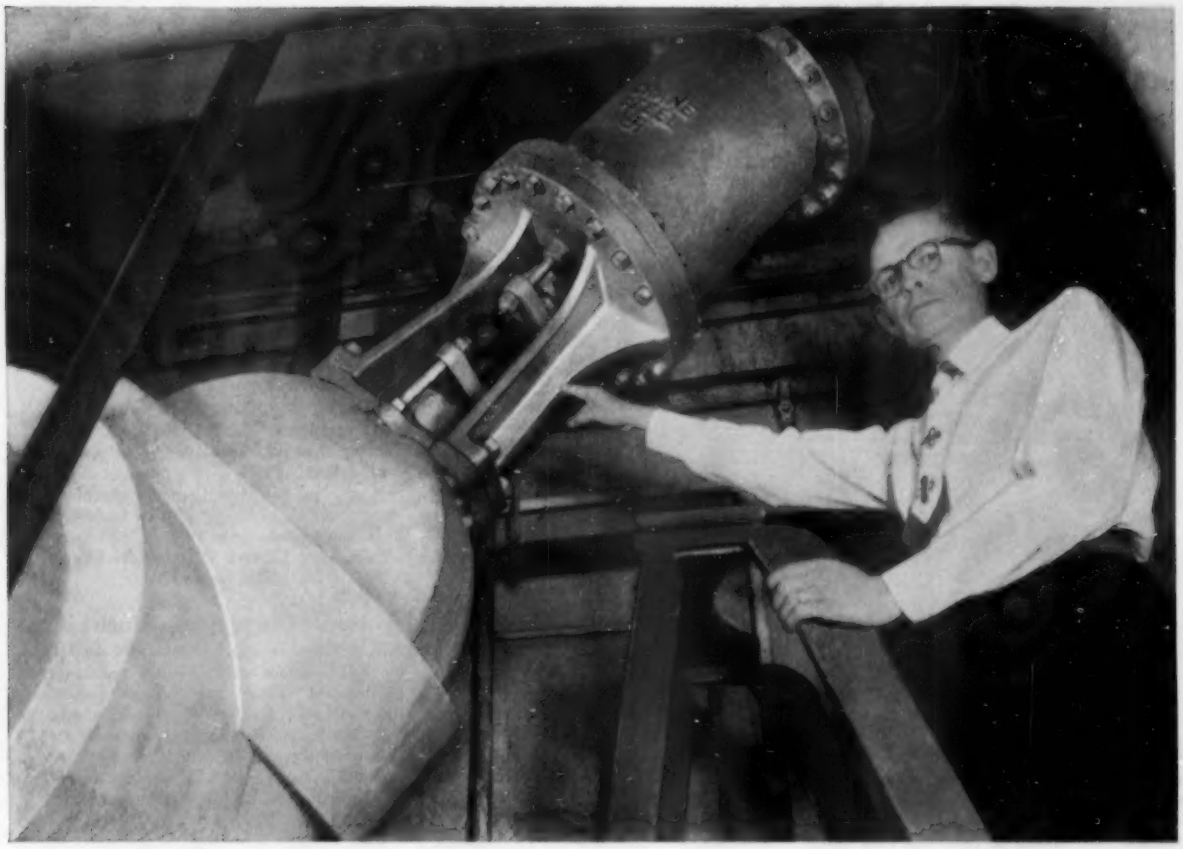
Blower has all-plastic impeller blade

212 • Heavy-duty 14-in. tubeaxial blower of unplasticized polyvinyl chloride is designed to expel corrosive air, fumes and gases. All-plastic impeller blade has an aerodynamically balanced spinner cap. Drive shaft, pulley, belts and sealed bearings are totally encased. Units may be installed vertically or horizontally.

Blower has range from 260 cfm at 875 rpm with SP of .025 to 2400 cfm at 2500 rpm with SP of .280. Brake horsepower is from .010 to .757 respectively. Unit is powered by a ¾-hp motor 3-phase, or 1-phase on request.

Tippett & Company, Inc, 419 Commonwealth Ave, Boston 15, Massachusetts

To obtain additional information on these items, use the post cards on page 173. Identify your request with the item number.



This CRANE VALVE begins new life after 37 years' service!

THE CASE HISTORY—World War One still raged when Cincinnati Gas & Electric Co. installed this Crane steel gate valve in 1917 at its Front & Rose Street Station. Ever since, it has safely controlled the main steam lead to No. 1 turbine—always making tight closure when needed—always responding smoothly to its hydraulic operator. For 37 years it has given such service with no more than routine maintenance—under operating pressure of 250 psi at 600 deg. F.

In 1954, the No. 1 turbine was renewed. The Crane steel valve—with complete confidence in Crane durable quality as demonstrated—was given limited preventive maintenance while down, and reinstalled in its original location.

Long life with minimum maintenance is a deeply rooted characteristic of Crane valves. That's what makes them industry's first choice today for low ultimate cost.

CRANE STEEL GATE VALVES
... a complete line

Here is steel casting at its best, by the pioneer in steel valve development. Here is value in durability . . . dependable operation . . . and in low-cost maintenance that sets Crane steel valves apart from the ordinary. They're made for every service—in all pressure classes and sizes. Consult your Crane Catalog or Crane Representative.

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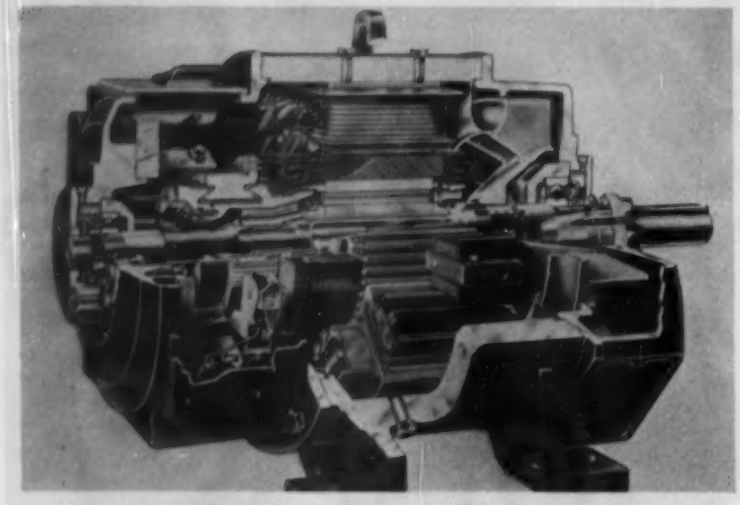
CRANE'S FIRST CENTURY . . . 1855-1955

More EQUIPMENT NEWS

Begins on page 164

Six items of timely interest in the electrical field



Standard line of dc industrial motors offer "dynamic response"

219 • These motors are described as producing the fastest and most accurate response ever offered in a standard design motor. Design features, according to manufacturer, are ability to take full load and overloads, to change speed rapidly, to maintain torque and tension, and reverse and stop quickly. Time required to accelerate to full speed has been cut in half. This is achieved through lower mechanical inertia, lower electrical inertia and higher commutating ability.

Units are available in 20 to 100-hp sizes, with complete range of mechanical enclosures. Complete information obtainable in manufacturer's bulletin C-2002.

Reliance Electric & Engineering Co, 1076 Ivanhoe Rd, Cleveland 10, Ohio

Sectional terminal block

222 • Unit design allows any number of circuit sections to be assembled into a compact 70-amp 750-v sectional terminal block. Three integrally molded serrated pins locate and secure each circuit section by mating with corresponding holes in adjoining circuit section.

Each section is covered and comes complete with factory installed contact. Three contact types are available for stripped or terminal ended wire with a range of No. 18 through No. 4 wires. Contacts are plated electrolytic copper with positive wire stops. Full details in bulletin PB.

Buchanan Electrical Products Corp, Hillside, New Jersey

Insulation resistance meter

223 • Portable 10-kv unit is designed to measure degrees of insulation resistance, polarization index and leakage current. Recommended for use with rotating electrical machinery windings, transformers and associated equipment with large dielectric capacities, the meter will measure insulation resistances to 200,000 megohms at 10 kilowatts.

Unit includes a built-in voltage stabilizer that provides current readings of .02 microamperes per scale division.

General Electric Company, Schenectady 5, New York

Vault-type transformers

225 • Network transformers with radiator are designed for strength and ease of cleaning and repainting, manufacturer states. Unit incorporates tank bracing with tubular radiation; the box-like bracing serving as a manifold connector for radiator tubes. Box structure stiffens tank wall and facilitates cleaning and repainting by leaving free space between tank and tubes. Complete information available on request to manufacturer.

General Electric Co, Schenectady 5, New York

Underfloor electrical system

221 • *Powerduct* distribution system offers concealed, large-capacity raceways with unlimited access possibilities. System is furnished in 10-ft lengths. It is installed with junction boxes, couplings, and self leveling supports on form, slab or fill prior to pouring finished floor. Preset inserts provide evenly spaced outlet points for standard connections to machines. Additional afterset connections can be made through floor to duct. Complete information on request.

Walker Brothers, Underfloor Div, Conshohocken 86, Pennsylvania

Capacitive level control

227 • Unit combines capacitive level sensing with electronic controls, terminating in air-pressure variations, suitable for operating a pneumatic-diaphragm control valve. Control is applicable to most non-adhesive chemicals, oils, refrigerants such as ammonia and freons, and condensed gases over a temperature range from 500 to –425 F. Unit derives a sensing signal from inert capacitive-type probe capable of being operated from high vacuum to pressures of 100,000 psi. Probe is connected to electronic circuitry that can be located as far as 1000 ft from sensing point.

Thermo Instruments Company, 1310 County Rd, Belmont, Calif.

For more data on these items, use post cards p 173. Identify your request with item number.

From coast-to-coast, A. P. GREEN warehouse stocks are available for immediate delivery to your plant...

You Lower Your Capital Investment . . . Your capital is not tied up in warehouse space.

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You Maintain Steady Production . . . With less down time. A. P. Green warehouse stocks are complete and are available for immediate delivery.

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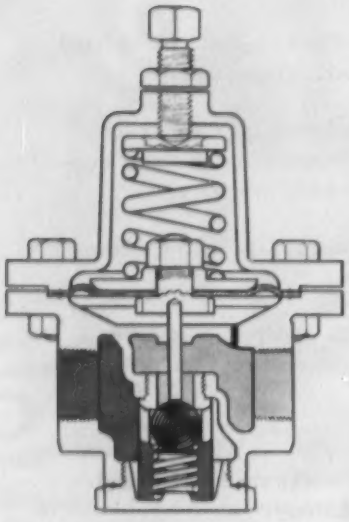
Six recent valve developments for varied applications



Pressure reducing, regulating valves have low pressure drop

213 • Self-contained, single seat valves operate within range of 300 psi inlet pressure and 3 to 250 psi delivered pressure. They are said to combine minimum size and weight with greater sensitivity. Units may be used with water, gas, steam, air, oil and other non-corrosive fluids.

Low pressure drop is achieved through use of venturi principle. Velocity of gas or liquid passing venturi orifice creates suction, reducing pressure in lower diaphragm chamber and opening valve wider to produce lower pressure drop.

Other features, according to manufacturer, are a spherical, self-cleaning inner valve and a large area built-in strainer. Unit is available in aluminum, bronze, iron, steel or other specified materials. Full details on request to manufacturer.

A W Cash Company, PO Box 551, Decatur, Illinois

Constant flow valves

216 • Units maintain flow rate of fuel oil or other non-abrasive fluids within 1%, up to 200 to 700 gph as desired. Valves regulate flow of fluids with viscosities to 250 ssu at operating temperature, static pressures as great as 500 psi, temperatures to 250 F.

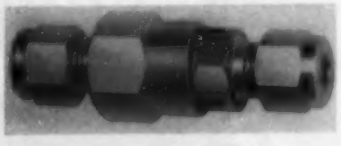
Askania Regulator Co, 240 E Ontario St, Chicago 11, Ill.

Polyvinyl chloride valve

214 • *Luncor* valve is the first completely molded polyvinyl chloride (PVC) valve ever introduced, according to manufacturer. The exclusive molding process gives the PVC material exceptional strength, protects its natural corrosion-resistance, and substantially reduces manufacturing costs. PVC is molded in rigid form, suitable for pressures to 125 psi and temperatures to 140 F.

A complete line of plastic fittings made of the same material is also available. These include caps, couplings, plugs, unions, reducing bushings, flanges, 45- and 90-degree elbows, and tees. Full details on request.

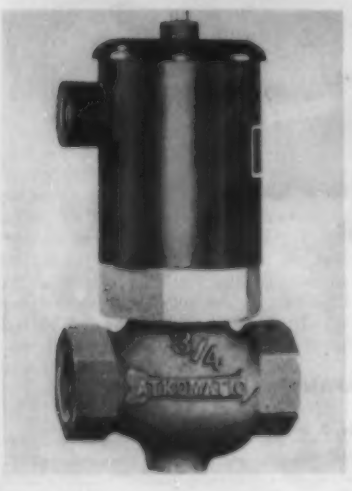
The Lunkenheimer Company, Cincinnati 14, Ohio



Ball type check valves

217 • Designed with *Swagelok* ends, units offer minimum flow resistance and provide positive reverse flow check, according to manufacturer. Available from stock in brass (max. operating pressure of 1000 psi) or stainless steel (max. operating pressure of 3000 psi). Maximum operating temperature is 150 F.

Crawford Fitting Co, 884 E 140th St, Cleveland 10, Ohio



Packless solenoid valves

215 • Semi-direct lift units are suitable for use with air, gas, freon, methyl chloride, water, oil or other media not harmful to bronze or 316 or 416 stainless steel.

In operation, when solenoid is energized, coil lifts pilot valve assembly from pilot valve orifice, thus relieving pressure on top of piston. Line pressure then lifts piston. When there is no line pressure, pilot valve assembly engages piston directly, lifting it from full port area. This is claimed to assure opening even at 0 psi. When solenoid is de-energized, a spring over the piston provides positive closing. Valve fits ½, ¾ and 1-in. pipe sizes.

Atkomatic Valve Co, Dept 1, 545 Abbott St, Indianapolis, Ind.

Double solenoid valves

218 • Pilot operated, air control valves are available in 40 different models in ¼ to 1-in. pipe sizes. Included are momentary contact 4-way, spring centered 3 position 4-way, and double 3-way action units. All valves are base mounted. They are designed for service on 5 to 125 psi. Full details on request.

Numatics Operating Valves, Milford, Michigan

For more data on these items, use post cards p 173. Identify your request with item number.

The control gage board for Astoria's No. 10 boiler. At top: Hays Model WSF for mounting above eye level. Right center: Hays Model WCF8P for eye level. Four mounting styles are available to meet special requirements.

NEWEST TYPE **Hays Draft Gage**

Consolidated Edison's new Astoria Electric Generating plant at Queens, N.Y. is equipped specifically for the purpose of producing electricity at the lowest cost per kilowatt, reliably and continuously.

To meet these exacting requirements, Con Edison selected Hays W Gage . . . a completely new design in draft gages. Like other Hays low pressure instruments, the draft gage operating mechanism consists of a diaphragm enclosed in a cast metal housing. For pneumatically transmitted readings of Air, Steam, or Water Flow, Pressures, Temperatures, Levels, Oxygen, etc., the operating mechanism employs a bellows. The outstanding new features include: 3-way atmospheric vent cock, easy zero check, removable units for simple adjustment, and Lucite scales for easy reading.

Functionally designed and beautifully styled, the Hays W Gage provides exactly what instrument men have long demanded—an easily adjusted, easy-to-read, dependable draft gage!

Write today for full information on the Hays W Gage. Publication 52-1060-210.

Automatic Combustion Control
Boiler Panels • CO_2 Recorders
Veriflow Meters and Veritrol
Gas Analyzers • Draft Gages
Combustion Test Sets
Electronic Oxygen Recorders
Electronic Flowmeters
Electronic Feed Water Controls
Miniature Remote Indicators

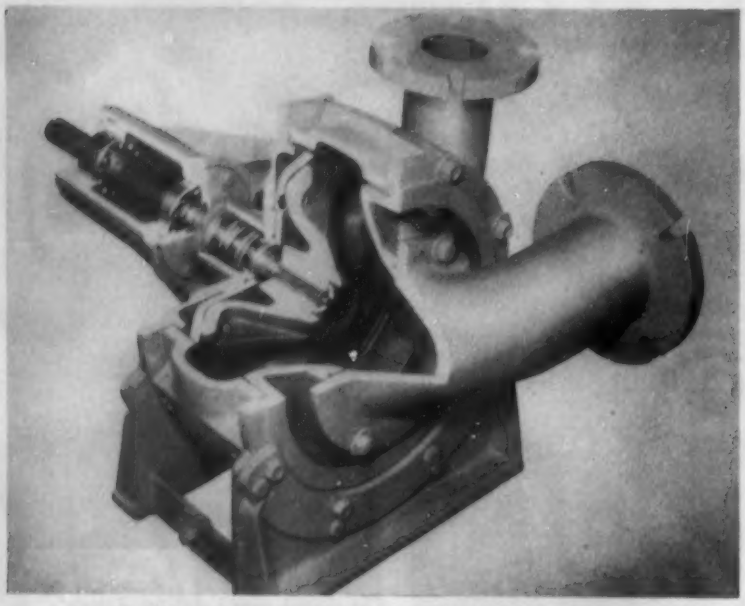
THE **hays** CORPORATION

MICHIGAN CITY 3, INDIANA

More EQUIPMENT NEWS

Begins on page 164

Is pumping your problem? Here's help!

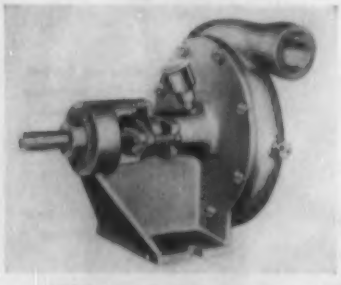


Solids pump eliminates conventional impeller

203 • *Torque-Flow* solids pump operates by transmitting power to a fluid pulp as in a fluid type torque converter. Although impeller is entirely out of flow path, it induces a vortex (swirl) that does the pumping. Rotating fluid mass forms a buffer between impeller and solid particles in flow so that few of them ever touch. Location of impeller is said to insure unobstructed passage of any liquid-solid combination that will pass through the piping itself. This eliminates any possibility of clogging, manufacturer states.

Pump is recommended for handling abrasives and soft, friable, waste, and fibrous materials. It can pump crushed ore pulp or ready-mixed concrete without binding on large chunks or suffering excessive wear. Waste materials can be pumped without clogging on rags, rope, string and rubber. Further information available in manufacturer's bulletin SP-10.

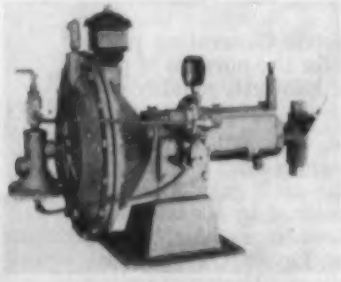
Western Machinery Co, 760 Folsom St, San Francisco, Calif.



Centrifugal pumps

208 • *Type H* bronze and *Type C* all iron pumps feature sealed ball bearings and simplicity of design, according to manufacturer. Only moving part is the impeller and shaft assembly. Semi-open type impeller permits pumping a percentage of solids. Available in ½, ¾, and 1-in. discharge pipe sizes. Details on request.

E L Price Pump Company, PO Box 357, Sonoma, California



Proportioning pumps

204 • *Type MSM* pump is operated by air or gas pressure and provides discharge ratios to 497/1. Unit can be regulated to inject additives in exact proportions to volumes carried in lines or vessels. Pump operates in an oil bath, is sealed against dust and atmospheric influences, and is equipped with external controls.

Texsteam Corporation, PO Box 9127, Houston, Texas

Automatic tube blower

207 • Aluminum blower utilizes a venturi jet head that combines steam and air at velocity of 600 mph at 60 lbs steam pressure. Tubes are cleaned from straight on or from a 45 deg angle with a single blast that reaches outer ring. Blower is also used for cleaning front sheet, uptake, pumps and other machinery or floors. Complete information available on request to manufacturer.

A W Chesterton Company, Everett 49, Massachusetts

Plastic-steel material

206 • *Devcon*, a combination of 80% steel and 20% plastic is recommended for many maintenance jobs including repairing machinery, filling holes in castings and metal tanks, fixing cracked steam lines, etc. It can also be used to make plastic and rubber molds, jigs, fixtures, dies for forming metal parts and countless other uses.

The material is supplied as a putty, *Devcon A*, and as a liquid, *Devcon B*. Two hours after addition of a hardening agent *Devcon* becomes a hard, rigid steel mass. It can then be sawed, drilled, threaded or machined like a piece of steel. No heat or pressure is required. Full details on request to company.

The Chemical Development Corp, Danvers, Massachusetts

Concrete additive

205 • Concrete additive, *Sikacrete*, is claimed to hasten set of poured concrete, reduce shrinkage, and increase both water resistance and surface hardness. It is recommended for overall increased concrete density, particularly where complete water resistance is necessary. Applications include tanks, pools, pump rooms or other below-grade pours. It is also used for quicker set and higher strength in new or replaced concrete machinery bases. *Sikacrete* does not interfere with other additives or admixtures. Request manufacturer's bulletin SI-54 for complete details.

Sika Chemical Corporation, 35 Gregory Ave, Passaic, N. J.

For details on these items use post cards p. 173. Identify request with item number.

CHECK THESE TOO . . .

Temperature controls	p 178
Miniature slip clutches	p 178
Liquid control meter	p 180
Electrical cable reel	p 182
Backstop clutch unit	p 184
Six-roller pipe cutter	p 184
Pillow block bearings	p 186
Mixed-bed demineralizer	p 186
Plastic headshields	p 188
Heavy-duty limit switches	p 188

4 out of every 10 KEYSTONE STEAM GENERATION are for MULTIPLE installations

Four of seven Erie City "Keystones" are shown at Republic Stamping & Enameling Co., Massillon, Ohio — subsidiary of EKCO PRODUCTS COMPANY, CHICAGO, ILL.

A few other well known users of two or more "KEYSTONES"

Pittsburgh Plate Glass Co.	2- 500 H.P.
Minnesota Mining & Mfg. Co.	2- 250 H.P.
Missouri Pacific Railroad Co.	2- 150 H.P.
Endicott-Johnson Corp.	2- 350 H.P.
Reynolds Metals Corp.	2- 150 H.P. 2- 200 H.P.
Fairbanks-Morse & Co.	3- 500 H.P.
Welch Grape Juice Co.	2- 400 H.P.
General Tire & Rubber Co.	2- 150 H.P. 1- 350 H.P.
American Can Co.	2- 400 H.P.
Gulf Oil Co.	2- 700 H.P.
Union Oil Co.	2- 800 H.P.
Thompson Products Co., Inc.	2- 250 H.P.

Compact, factory assembled and FACTORY FIRE TESTED "Keystone" steam generators fit into any plant's variable steam needs. Multiple "Keystones" permit high efficiency operation. During periods of low loads take one or more units off the line—for high loads the rapid steaming "Keystone" responds quickly to increased requirements.

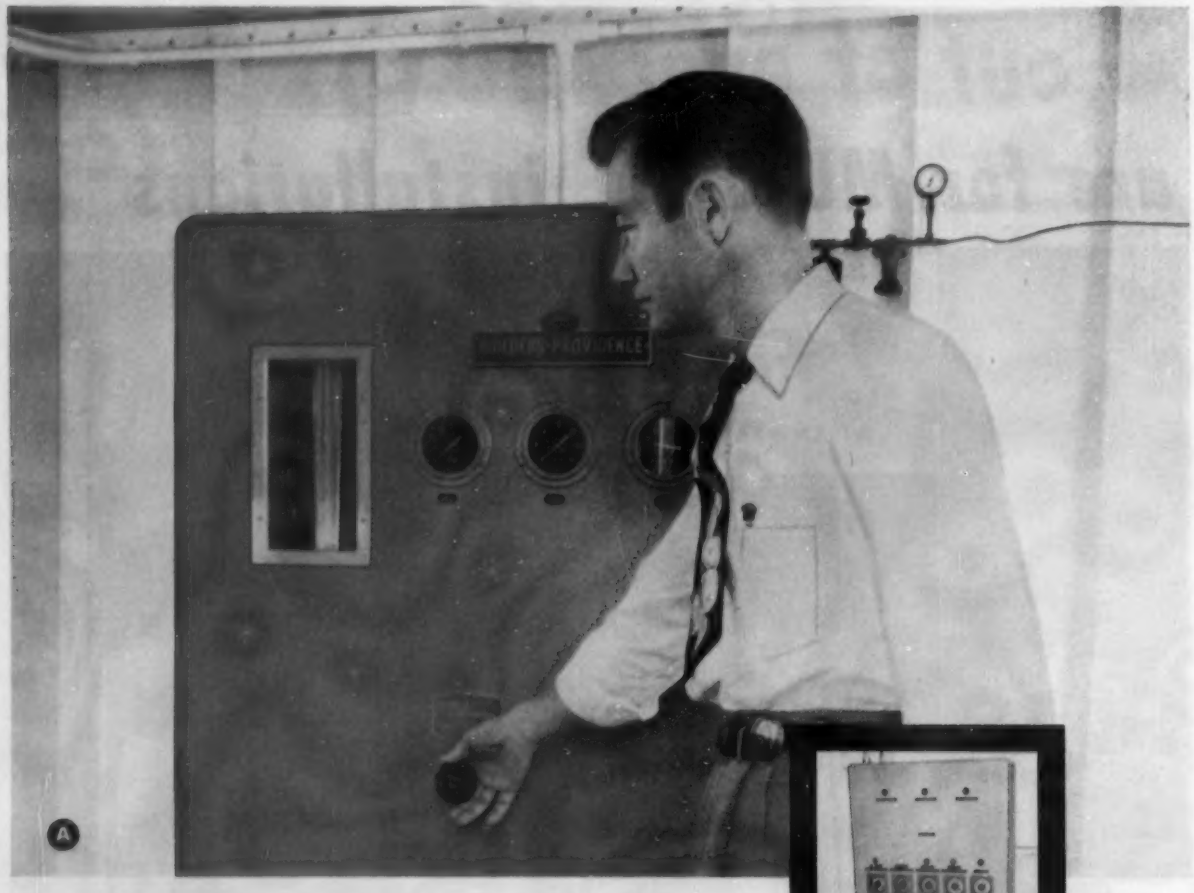
If your problem is the need for steam at some remote location in your plant, investigate the use of one or more Keystones. Indoors or outdoors "Keystones" are satisfying all types of steam needs. Bulletin SB-51 completely describes the "Keystone" steam generator.

ERIE CITY
114 Years in Steam Generation

You can depend on Erie City for sound engineering

ERIE CITY IRON WORKS • *Erie, Pa.*

STEAM GENERATORS • SUPERHEATERS • ECONOMIZERS • AIR PREHEATERS
UNDERFEED AND SPREADER STOKERS • PULVERIZERS



CHLORINIZER keeps 'em clean...

. . . AT STATION B OF SAN DIEGO GAS AND ELECTRIC CO., this Builders Model HCVS 3000 lb. per day Chlorinizer reduces to a minimum hand cleaning of condensers . . . keeps condenser slime under control throughout the year. To do the job, heavy chlorine dosages are "shot" to 4 points of application: 3 pump suctions and 1 open channel. Chlorinizer, with its simple tantalum diaphragm control valve and hydraulic control system, is ideally suited to this type of automatic time-sequence control. Very slight modification of the basic Chlorinizer (Photo A) was required. The companion-type control panel (see Photo B) is an economical combination of off-the-shelf components . . . easy to adjust or service . . . low in both initial and upkeep costs.

This installation was made in 1952 at the 100,000 KW Station B, and the Chlorinizer and control panel have been in continuous service since then.

Find out how Builders Chlorinizer can solve your slime control problems . . . in main condensers . . . in heat exchangers . . . in all types of cooling systems. For Application Memo 840-J9 describing Chlorinizer slime control system — also full details on Builders Chlorinizers — write Builders-Providence, Inc., 354 Harris Ave., Providence 1, Rhode Island.

BUILDERS-PROVIDENCE

DIVISION OF B-I-F INDUSTRIES, INC.

BUILDERS IRON FOUNDRY • PROPORTIONEERS, INC. • OMEGA MACHINE CO.

B-I-F METERS FEEDERS CONTROLS

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Power a McGraw-Hill Publication

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New York 36, N. Y.

HEATING AND REFRIGERATION

1 **Oil-fired unit heaters.** Applications, selection and construction data in illustrated bulletin. Delta Heating Corp, Dept UHC, Trenton 8, New Jersey.

2 **Storage water heaters.** Design, operation, construction data. Charts, photos and diagrams in 16-page bulletin 54-75A. American District Steam Co, Inc, North Tonawanda, N. Y.

3 **Tube-ice machines.** Operation, features, applications of automatic units described in 23-page bulletin TI-4. Henry Vogt Machine Co, 1000 W Ormsby St, Louisville 10, Ky.

ELECTRICAL EQUIPMENT, CONTROLS

4 **Panelboards** for lighting and distribution. Photos, construction and application data in 24-page bulletin 501. Continental Electric Equipment Co, Box 1055, Cincinnati 1, Ohio.

5 **Distribution transformers.** Self-protected pole-type units rated 100 kva and below. Details on urban and suburban application in illustrated 24-page bulletin GEA-6136. General Electric Co, Schenectady 5, New York.

6 **Capacitors** for primary and secondary power distribution circuits and industrial circuit applications. Ratings, construction data, specs, photos in 12-page bulletin PFC-104. Tobe Deutschmann Corp, Norwood, Mass.

7 **Battery selection** techniques emphasized in 20-page illustrated bulletin 310. Data on storage batteries for stand-by power, emergency lighting and switchgear applications. Dept SP-665, Exide Industrial Div, The Electric Storage Battery Co, Box 8109, Philadelphia 1, Pennsylvania.

8 **Voltage regulator** for 60 cycle ac machines. Photos, specs, applications in 4-page bulletin T-3300. Inet Div, Leach Corp, 4441 Santa Fe Ave, Los Angeles 58, California.

★ **Magnet wire catalog** (pocket-size edition). Indexed, illustrated with photos, charts, tables and drawings. Bulletin C-79-12A. ★Request direct on company letterhead. Anaconda Wire & Cable Co, 25 Broadway, New York 4, N. Y.

9 **Switches,** rotary and multipole, for instrument, transfer and selector use. Wiring charts, drawings, dimensions, ratings in 12-page catalog 3054-IN. Electro Switch Corporation, Weymouth 88, Massachusetts.

10 **Enclosed fuse cutouts.** Line includes 50 and 100 amp cutouts in 5.5 and 7.5 kv ratings. Photos, applications, technical data, in 36-page bulletin GEA-6208. General Electric Company, Schenectady 5, New York.

MAINTENANCE MATERIALS, EQUIPMENT

11 **Filter cloths** for all types of dust collectors and filters. Selection data, photos, charts, case histories in 6-page bulletin. Filtration Fabrics Div, Filtration Engineers Inc, 165 Oraton St, Newark, N. J.

12 **Red lead paints** for rusted, weathered, or treated new galvanized steel. Application data, formulations in 5-page technical letter 9. Lead Industries Association, 420 Lexington Ave, New York 17, New York.

13 **Chemical cleaning** for power and industry. Methods of cleaning heat exchangers, boilers and other equipment. Illustrated 12-page bulletin. Sumco Engineering Company, 144 Centre St, Brooklyn 31, New York.

14 **Alloy tool bits** for use in cutting range between high speed steel and carbides. Applications, speeds and feeds, brazing data in 4-page bulletin. Allegheny Ludlum Steel Corp, 3010 Oliver Building, Pittsburgh 22, Pa.

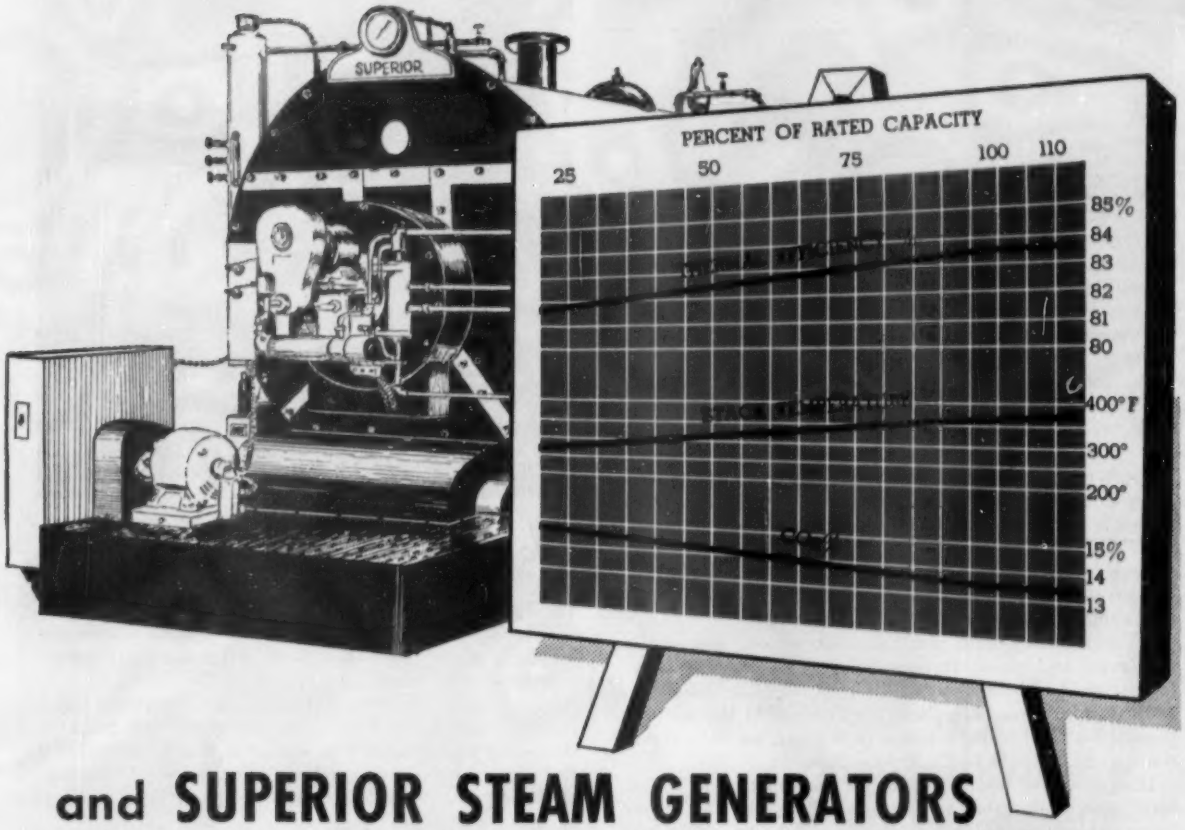
MATERIALS HANDLING

15 **Coal valve** construction data, features, installations, dimensions in 8-page illustrated bulletin. Stock Equipment Company, Hanna Building, Cleveland, Ohio

(Continued on page 228)

PERFORMANCE

is part of the PACKAGE



and SUPERIOR STEAM GENERATORS are rated for actual operating conditions

Superior Steam Generators are fully automatic, burning oil or gas or both. 18 sizes from 20 to 600 b.h.p. for pressures to 250 p.s.i. or for hot water. Write for catalog 700.

The payoff in performance is in your plant—here is where a steam generator must live up to the claims of its maker or you are the loser. Every Superior Steam Generator is "Performance Rated" on the basis of tests conducted under conditions duplicating those of actual service and is guaranteed on the results of these tests. The chart above shows typical performance of a Superior Steam Generator at 100 lbs. pressure. It is based on tests conducted by professors from Lehigh University on a boiler which had been in actual service for over a year. You can depend on results like these throughout a longer serviceable life when you specify Superior Steam Generators.

for performance you can **BANK** *on*

SUPERIOR COMBUSTION INDUSTRIES INC.
TIMES TOWER, TIMES SQUARE, NEW YORK 36, N.Y.

SUPERIOR
STEAM GENERATORS

George Edwards' Scrapbook

What are we squawking about?

Average American factory worker in all industries earns about $14 in an eight-hour day. I understand the pay for a day's work in England is about $4.22. And in that workers' paradise of Russia a person is very generously handed about 99 cents for his daily toil.

We not only are the richest people on the earth dollar-wise but, being gradually relieved of the time-consuming drudgery of hand labor, we prosper physically, culturally and spiritually besides.

Since the turn of the century, for example, life expectancy in America has gone up from 49 to 69 years. One reason is that death rate for infants under one year dropped over 79%.

Back in the good old days of 1910, only 44 out of each 100 boys and girls of high-school age attended school. Now that number has almost doubled to 83.

We own three-fourths of all automobiles, one half of all telephones and radios, three-quarters of all television sets in the world. These figures hold true for other goods as well. But we have only about one-fifteenth of the world's population. And when it comes to housing, we have eight times as much space as the average Russian.

How about the future? Estimates show that by 1975 the total value of our goods and services will double. Our labor force will increase by 33%, while our population will go up by 21%. Comparing our lot with the rest of the world, what are we squawking about?

Good man is self-winding

Ever watch people just starting in your plant or office? One takes hold and can't find enough hours in a day to do all the things he'd like to do. The other does only the jobs he is given, then sits around waiting for an assignment.

I've learned that a person "belongs" if he takes hold and is self-winding. What's your experience been?

Do others know what you say?

Some advertisements remind me of the man who sued his wife for divorce. The judge asked what grounds he had. "Judge," he answered, "She just talk and talk—all day." The judge inquired, "What does she talk about?" The man replied, "She don't say."

Ad writers should remember that people are interested in themselves—in their problems. Give engineers information that tells them how to save money, instead of talking about the "biggest," the "mostest" and the "bestest" product.

Go south, young man...

Vacationing friends are going farther south each year. There was a time when a trip to Florida or California was the usual winter trip—and we all envied the lucky people who could take the time to go.

Here, lately, the Virgin Islands, the Bahamas, Cuba, Bermuda and Central America are giving our Southern states stiff competition. One reason is that it takes only a few hours more to reach one of these tropical playgrounds by plane. Another is that the slow tempo of living is relaxing to most Americans.

After a week or two of taking it easy along a palm-lined beach, for example, one comes back to pick up his burdens with a new perspective on life.

Travel, like engineering, is a state of mind. Some of us stick to the old equipment and the old ways of doing things. Others lose no time in adopting new ideas and exploring them to the fullest. Perhaps an engineer should be the first to accept new ideas, because he is greatly responsible for our ever changing way of life. Yet, many of us are satisfied to keep doing things in the same old way.

About the time we feel we're in a rut, one way to snap out of it is to take off, and spend a few days in a new environment. If you feel hopelessly tangled in a network of details, why not go south for a few days and let the tropical breezes brush out the cobwebs?

... names will never hurt you

Pay no attention to ill-natured remarks about you. Just live so nobody believes them. Disordered nerves and a bad digestion are a common cause of backbiting.

George Edwards
Engineer

Write for the Klinger Master Catalog, which describes the complete range of Klinger products.

First in 1886
Foremost Today

"KLINGERIT," original compressed asbestos sheet packing, was first manufactured over seventy years ago and is used today in ships and industry and power plants all over the world. It resists the action of steam, hot and cold water, hot and cold oils, petrol, benzine, the by-products of the coal industry, most acids, and chemicals in general. It withstands the highest pressures and temperatures, and will not burn, disintegrate or squeeze out. It is available in thicknesses from .008" to ¼" and in sheet sizes up to 240" x 96". It can also be supplied in the form of ready-cut gaskets, and with graphited or non-graphited surfaces.

stands up to every test!

RICHARD KLINGER LIMITED, KLINGERIT WORKS, SIDCUP, KENT, ENGLAND
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Telephone: WILBANK 3181 Cable: ROBCO
Branches at: SYDNEY, HALIFAX, OTTAWA, TORONTO, HAMILTON, WINNIPEG, EDMONTON, VANCOUVER, QUEBEC CITY.

Manufacturing Licensees for U.S.A.
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95, RIVER STREET, HOBOKEN, NEW JERSEY, U.S.A.
Telephone: HOBOKEN 2-7915 Cable: KLINGDALE

Distributors and Agents in principal cities.

G/5/55/3

Stair treads by BLAW-KNOX

you can easily make

every step a safe step

Indoor or outdoor, you can rely on Blaw-Knox Stair Treads to provide the safety you want in your plant.

Designed for tremendous strength against impact, these stair treads are made with twisted cross bars and rolled diamond checkered plate nosing—as illustrated.

But, when desired, you can get treads with a twisted cross bar nosing or an abrasive nosing. And for specially slippery conditions we can supply you with serrated cross bar treads.

Just tell us what your application is and we'll offer our recommendations as to the best type of tread for your job.

Only Blaw-Knox Electroforged® Steel Grating and Stair Treads —have these five exclusive features:

1. rigid one-piece construction—easy to install
2. all surfaces accessible—easy to paint
3. no sharp corners to clog—self-cleaning
4. maximum open area—for light and ventilation
5. non-slip twisted crossbar—safe footing

A short note will bring you a copy of new Bulletin No. 2365-R —a dimensional sketch will bring you a quotation.

BLAW-KNOX

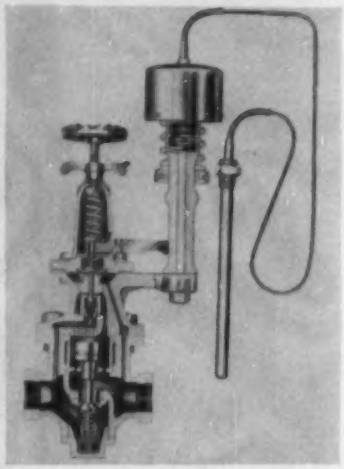
BLAW-KNOX COMPANY
2029 Farmers Bank Building • Pittsburgh 22, Pa.

BLAW-KNOX EQUIPMENT DIVISION
GRATING DEPARTMENT

GRATING APPLICATIONS: floors • platforms • walkways • catwalks • stair treads • fan guards • shelving • and many other uses, both outdoors and indoors, for versatile steel grating.

More EQUIPMENT NEWS

Begins on page 164



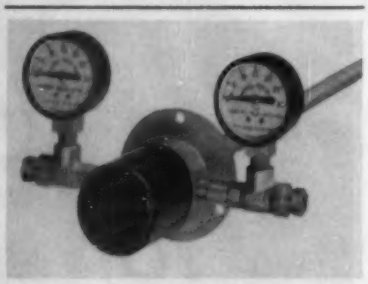
Pressure-temperature control

239 • Modulating pressure - temperature regulator is available in six temperature ranges. A minimum of 10 lbs pressure differential is required to operate the valve.

As temperature tends to vary, thermostatic control unit acts upon pressure regulator to reduce or increase steam pressure. Pressure will modulate smoothly and rapidly between initial setting and zero, thereby preventing overrun. Rate of pressure modulation is adjustable. Sizes are ½ to 2-in. with screwed ends and 2½ to 6-in. with flanged ends. Full details on request.

O C Keckley Co, 400 W Madison St, Chicago 6, Illinois

For more data on these items, use post cards p 173. Identify your request with item number.



Pneumatic temperature control

240 • Non-bleed differential expansion type control is designed for precision regulation of heating, cooling, ventilating, air conditioning, dew point control and industrial processes. Typical applications include operation of diaphragm valves and damper motors. Temperature range is from 35 to 135 F. Sensitivity can be adjusted from ⅛ to 2 psi per 1 deg temperature change—gradual acting. Full details in bulletin 308.

The Powers Regulator Company, Dept PRN, Skokie, Illinois

Miniature slip clutches

241 • Complete line of miniature slip clutches are designed to limit or control torque while permitting variation in speed between driving and driven mechanisms. One series of slip clutches uses silicone

WHY "DOCTOR" YOURSELF?

You save trouble and money in the long run when you call in a Specialist!

Prescribing lubricants for your complicated machines is, in a way, like prescribing medicine for yourself...a single mistake can be fatal. That's why it pays to call in a Specialist for consultation and advice when lubrication problems arise.

Socony-Vacuum has been serving industry for 89 years—far more than any other oil company. During this time we have built up a vast storehouse of lubrication knowledge and experience—have used this priceless information to develop top-quality oils and greases for every industrial need.

Working with you, we will apply this knowledge to diagnose your lubrication needs, prescribe the right oils and greases—install a program of Correct Lubrication. This cooperative effort will improve your production—reduce your maintenance costs.

Can you afford to accept anything less for your plant? Call your Socony-Vacuum representative.

Socony-Vacuum

SOCONY-VACUUM

Correct Lubrication

FIRST STEP IN CUTTING COSTS

SOCONY-VACUUM OIL COMPANY, INC., and Affiliates: MAGNOLIA PETROLEUM COMPANY, GENERAL PETROLEUM CORPORATION

PHILA-FEEDER

...new low cost, quality chemical pump

Can you inject water treating chemicals into your boiler for less than 2 cents per day?

With the *Phila-Feeder* you can, figuring cost of pump and current.

The Phila-Feeder is one of a complete line of Philadelphia chemical proportioning pumps designed for capacities from 2 c.c. to 3600 g.p.h. and for pressures to 35,000 p.s.i. Years of field experience on thousands of pumps have proven their worth.

Phila-Feeder is a quality pump with such features as external packing adjustment for positive load without springs, bronze crosshead, screw adjustment of eccentric, no wear roller bearings, sturdy channel steel base —*And at the lowest price.*

PACKAGED CHEMICAL FEED UNITS

Self-contained assemblies comprising various sizes of welded-steel storage tanks and simplex or duplex Phila-Feeder Pumps with all necessary auxiliaries and piping ready for connection to chemical feed piping and electrical circuits.

Adaptable to manual or automatic control of boiler feed requirements.

Write for catalog. Philadelphia Pump and Machinery Company, Inc., 1513 Race Street, Philadelphia, Pa.

PHILADELPHIA PUMP
AND MACHINERY COMPANY INC.

SUBSIDIARY OF AMERICAN METER COMPANY EST. 1836

More EQUIPMENT NEWS

Begins on page 164

putty as transmission material while a second series utilizes principle of cantilever spring deflection. In both cases, accurate torque rating can be constantly maintained in torques to 20 in. lbs. Sizes range from ¼ in. dia x ⅝ in. wide to 2¼ in. dia x ½ in. wide. Full details on request.

Radial Metal Products, Inc.
1044 Linwood St, Brooklyn 8, N.Y.

TV-telephone intercom system

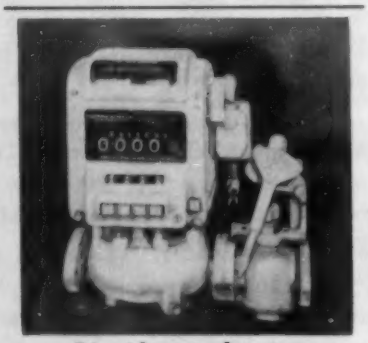
242 • System resembles conventional 17-in. television receiver with phone handset attached beside the screen. When caller lifts receiver his image appears simultaneously on half of his screen and half of screen of the called party. Latter's image shows on other half of each screen when he answers the call.

Either party can adjust screen, making entire area available for viewing blueprints, documents, signatures, etc. When not in use as an intercom, screen may be used for monitoring industrial closed-loop TV, receiving subscription TV, or taking programs from the air as with a standard receiver.

As many stations as desired can be installed in a single system. Picture and sound are carried over coaxial cable or through microwave relay links.

Kay Laboratories, 1090 Morena Blvd, San Diego, California

For more data on these items, use post cards p 173. Identify your request with item number.



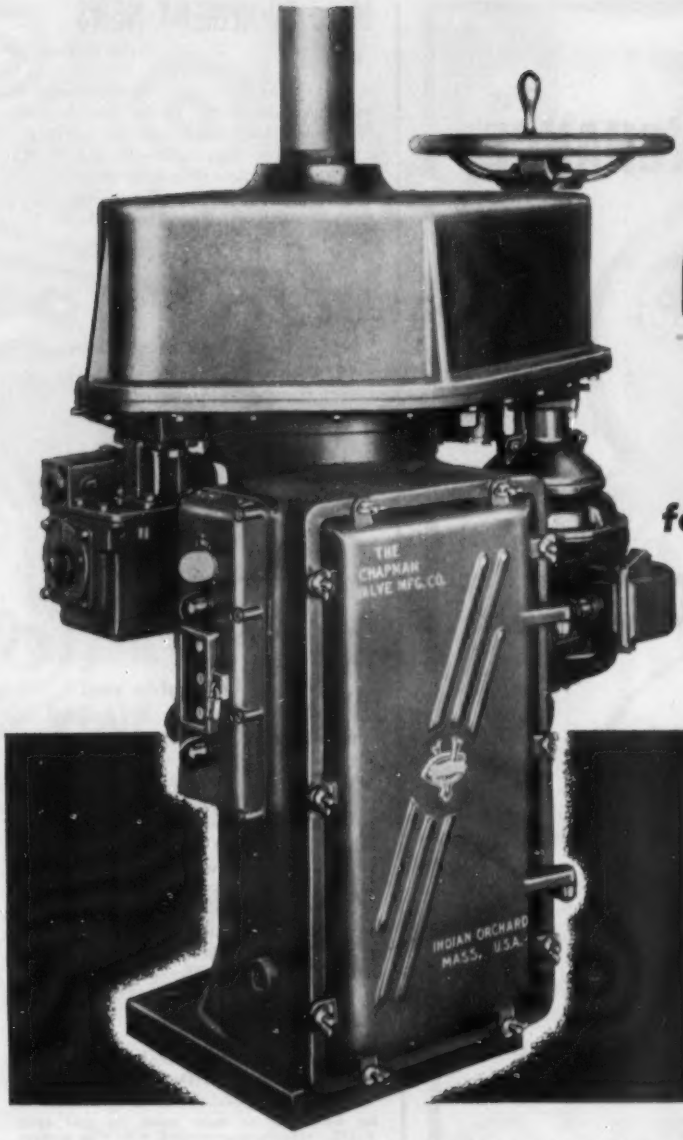
Liquid control meter

243 • Unit features built-in explosion-proof electrical switch that is actuated automatically when any desired quantity of liquid has passed through the meter. The switch can be used to turn pumps on or off, actuate solenoid valves, start agitators or control other cycling operations by use of

Simple and RUGGED...

CHAPMAN'S MOTOR UNIT

for Valves, Floorstands and Sluice Gates



Floorstand equipped with Motor Unit . . . control panel, motor, limit switch and push button station.

Simple, durable mechanism of Chapman's Motor Unit. Handwheel remains stationary during motor operation.

Chapman Motor Units have fewer components than any other units, providing greater dependability, much lower maintenance costs.

There are only two pinions and two gears in the motor reduction train: drift is eliminated and lash is negligible. Your valves seat tight, but not too tight. Operation is *always* smooth and trouble-free.

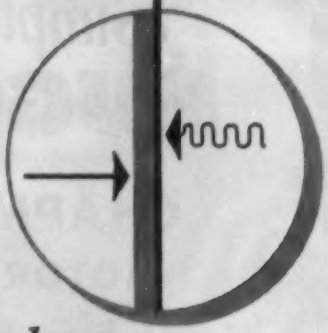
You can mount the Chapman Motor Unit in any position, at any angle required. The rugged stub-tooth gears require no grease or oil bath . . . yet run smoothly, quietly, with minimum wear.

Weatherproof and steam tight, Chapman's floorstand units are shipped completely wired, ready to connect to your power leads, for easy, rapid installation. This modern motor unit is dependable and economical. Send for *new* catalog No. 51.

The CHAPMAN Valve Manufacturing Company
INDIAN ORCHARD, MASSACHUSETTS

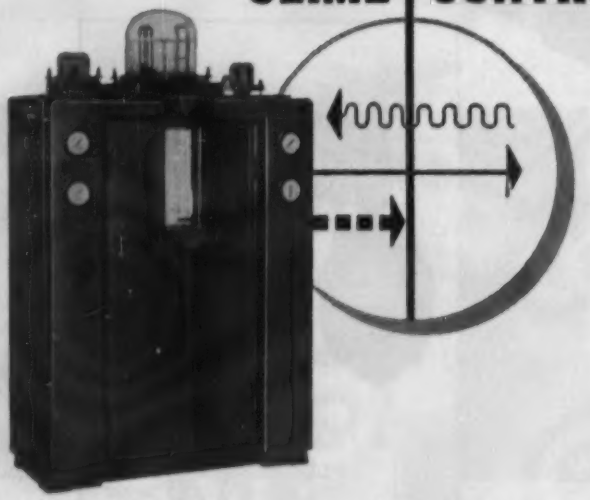
Where you need

HEAT | EXCHANGE



Be sure you have

SLIME | CONTROL



Whether you heat or cool water for make-up, process or any other use, you will need Wallace & Tiernan Chlorination to help combat slime problems introduced by water-borne bacteria or air-borne bacteria.

With slime control equipment designed for any need, built for lasting and dependable service, highly accurate and backed by over 40 years of successful application experience, Wallace & Tiernan Chlorination can help you increase the efficiency of your plant and cut operating costs. For further information write our Industrial Division.

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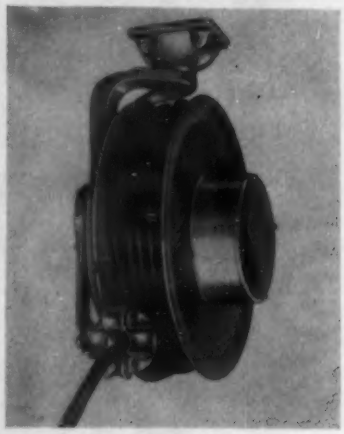
CD-39

More EQUIPMENT NEWS

Begins on page 164

suitable relays, etc. This switch feature is available either with or without mechanically coupled *Auto-Stop* valve, that is also actuated by the tripping mechanism in the register. Complete details on request.

Neptune Meter Company,
19 W 50th St, New York 20, N. Y.

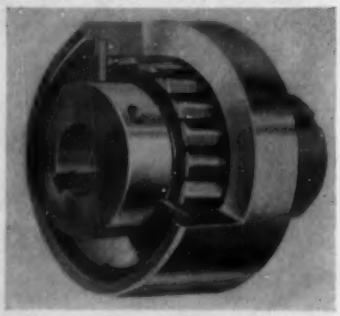


Electrical cable reel

244 • Heavy-duty unit is designed to speed pay-out and take-up of electrical supply cables on hoists, cranes, and other mobile electrical equipment. Unit is available with either plain or pivot base. Pivot base permits swivel of 330 deg on self-lubricating bearings. Large diameter spring housing permits use of a long spring operating on a large diameter hub. This results in constant torque with minimum spring stress, according to manufacturer. Spring release clutch permits back-winding without spring damage. Operation is based on 30 amp, 600 v, ac, 300 v dc, 1 to 8 conductor collector rings. Weight of unit is approximately 25 lbs.

Industrial Electrical Works,
1503 Chicago St, Omaha, Nebraska

For more data on these items, use post cards p 173. Identify your request with item number.



Plain bearing cam clutches

245 • *PB Series* clutches are basically designed for operation in lower speed and torque ranges and can be used with standard shafting on press feeds, two-speed drives and as backstop and overrunning clutches on machine drives.

These self-contained units include long bronze bearings, hardened and ground steel

Heat-treating and physical testing equipment shown at left is used for quality control of welding operators and for development of new welding procedures.

Daily rigid testing is your insurance of quality welds in

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At Navco, a continuous parade of weld specimens are processed in the new, modern physical-chemical testing laboratory. It is here that weldments are studied metallographically and tested physically—all on a rigid schedule of quality control practices. Navco customers have benefited from progressive quality control practices for more than 40 years; they have come to know that piping installations, engineered, fabricated and erected by Navco, are precise, accurate and dependable.

Call on NAVCO for your next piping job.

This Rockwell hardness testing machine measures the hardness of weld specimens as a guide to proper procedures for heat-treating of welds.

A laboratory technician cuts a sample from a pipe weld prior to grinding and polishing for metallographic examination.

Here a weld specimen is etched to outline the grain structure for further metallographic study.

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for HIGHER pressures

Type "S-R" Ajax Spiral Wound Gaskets with solid metal reinforcing ring which locates gasket inside bolt circle, prevents lateral expansion under pressure and acts as a compression gauge for maximum gasket efficiency. For pressures up to 1500 psi.

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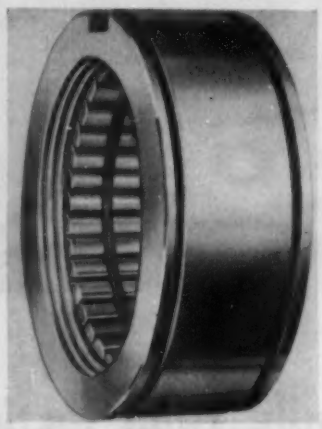
More EQUIPMENT NEWS

Begins on page 164

inner and outer races, cam and energizing spring assembly, snap ring, and a grease fitting for lubrication. Ratings range from 8.2 to 545 ft lb torque.

Morse Chain Co, 7601 Central Ave, Detroit 10, Michigan



Backstop clutch unit

246 • Unit is particularly advantageous on gear reducing applications where backstop can be incorporated into a bearing bore and existing shaft extension can be used for an inner race. Outer diameter of clutch is basically the same as that of a standard bearing. Diameter tolerance is held to insure proper fit (without pressing) into a continuation of the adjacent bearing bore. Full details on request.

Formsprag Co, 23601 Hoover Rd, Van Dyke, Michigan

For more data on these items, use post cards p 173. Identify your request with item number.

Six-roller pipe cutter

247 • Heavy-duty cutters for ⅛ to 2-in. pipe are designed with six rollers to prevent spiraling when used with power drives. Claimed features include rollers in hook to provide true alignment and to assure square cut-off; high alloy steel cutter wheels that leave little burr; single cutter wheel in sliding block; malleable frame, formed to fit hand and guaranteed warp-proof.

Toledo Pipe Threading Machine Co, 1431 Summit St, Toledo, Ohio

Belt conveyor idler

248 • Cable-suspension idler for belt conveyors is claimed to shape itself to load and have excellent resistance to abrasion. Suspended from two bearings, it carries

NO WAITING . . .

Popular sizes carried in stock!

Sizes, capacities and prices on B & G Series 1522 and 1531 Stock Pumps are given in a bulletin available upon request. Send today for your copy.

B & G manufactures a comprehensive line of Hydro-Flo Centrifugal Pumps and Heat Exchangers for industrial applications. Send for catalogs.

These are *the* pumps which stand up under hard service in industrial plant applications! For your convenience, a stock of most commonly used sizes is maintained at the factory—ready for immediate shipment.

The leak-proof "Remite" Mechanical Seal alone makes these pumps a *buy!* This new-type Seal is harder than glass—wear-proof, corrosion-resistant. It's self-lubricating and eliminates the usual leakage through the packing gland—assures trouble-free operation.

Smooth running . . . quiet!

Durable high grade steel shaft is oversized and super-finished to assure smooth, quiet operation and long life. All parts are machined to rigid specifications, carefully inspected and assembled—assurance of minimum installation and maintenance expense. B & G Series 1522 and 1531 Pumps kept in stock at the factory are bronze-fitted only, but are available as all-iron, all-bronze or stainless steel units.

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COMPANY
Dept. DT-36, Morton Grove, Ill.
Canadian Licensee: S. A. Armstrong Ltd., 1400 O'Connor Drive, Toronto, Canada

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- LONGER LIFE through extra wide bronze seats that resist pitting and corrosion
- LONGER LIFE through heavy shoulders that can take severe wrenching
- LONGER LIFE through a nut and body which are practically indestructible. (They're made of air-refined, high test malleable iron.)

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UNIONS

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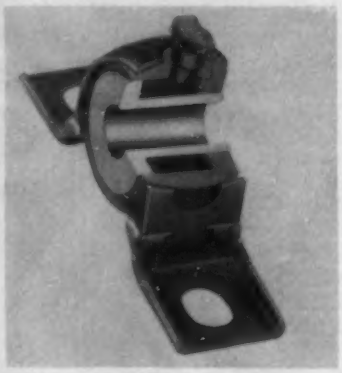
More EQUIPMENT NEWS

Begins on page 164

belt on resilient, pressure-molded neoprene discs, all of same size and all revolving at same speed. Bearings are locked in place with spring clips and can be changed without interrupting material flow. Unit permits conveyor heights from 13¼ to 15¾ in. and is available for belt widths of 24, 30 and 36 in. Request bulletin LD-103.

Joy Manufacturing Company, Oliver Bldg, Pittsburgh 22, Pa.



Pillow block bearings

249 • *Permawick* bearings incorporate oil-metering principle claimed to extend lubrication life considerably over felt-packed bearings. Wicking material holds 9 times its weight in oil and releases oil only as needed. Pillow block design features include precision cast ball carrying bronze bushing, oil reservoir and oil cup; snaplock top pre-punched with holes at 90 deg to permit mounting in any position; base that can be bolted or welded in position. Available with bores of ½ to 1½ in.

Congress Drives Div, Tann Corp, 3750 E Outer Dr, Detroit 34, Mich.

For more data on these items, use post cards p 173. Identify your request with item number.

Mixed-bed demineralizer

235 • Portable device is used to produce water of low total dissolved solids, low CO_2, low silica content and low conductivity. In service, inlet hose is connected to raw water supply and outlet connected

"33,000 HOURS proved the choice was right!"

When a prominent North Carolina community converted its power plant to diesel operation, it called in Sinclair Lubrication Engineer Jim Holt for his recommendations on proper lubricants.

Mr. Holt reports, "I recommended Sinclair RUBILENE® My previous experience convinced me that this diesel lubricating oil would provide maximum wear protection for this power plant's six 1000 K.W. diesel engines. RUBILENE also guards against sticking rings and prevents excessive wear of cylinders, pistons and other moving parts operating continuously for long periods.

"RUBILENE was the right choice," Mr. Holt continues. "After 33,000 hours of near-continuous operation, bearings show very little discernible wear – and there's not a sign of erosive or corrosive action. *Oil consumption is remarkably low*, considering the prolonged operating hours under overload. All six 1000 K.W. engines, with a total output of 6400 K.W. per hour, *use a total of only 1 barrel of oil a day!*"

Why not give a Sinclair Lubrication Engineer the chance to help solve *your* lubrication problem. *There's no obligation.* Contact your local Sinclair office or write Sinclair Refining Company, 600 Fifth Avenue, New York 20, N.Y.

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After seeing the daily operating records kept on Buell 'SF' Electric Precipitators and Cyclones by our customers . . . many executives and engineers have come away with a fresh viewpoint on industrial dust collection.

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Meanwhile, get the complete facts about all three Buell Systems for industrial dust recovery. Our clearly worded Brochure—The Collection and Recovery of Industrial Dusts—will give you the whole story fast. Simply write Dept. 50-B, Buell Engineering Company, 70 Pine Street, New York 5, N. Y.

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More EQUIPMENT NEWS

Begins on page 164

either into pipe line or left free to be put into container where water is required. Faucet, to which raw water inlet adapter is fastened, should be used to regulate flow through the unit. Flow rate is 1 to 2 gpm maximum.

Unit has capacity of approximately 1500 grains total dissolved solids. During each run it is capable of demineralizing 250 gallons of raw water containing 100 ppm total electrolytes; or 125 gallons of raw water containing 200 ppm total electrolytes.

When unit is exhausted, resins may be removed, discarded and replaced with a new refill. However, resins can be regenerated and reused. A conductivity meter is used to indicate dissolved solids content of the effluent water and will show when regeneration or refill is required.

The Permutit Company, 330 W 42nd St, New York 36, N. Y.

Plastic headshields

233 • Designed for head protection of welding operators these shields are made of molded fiber glass reinforced plastic. They offer light weight, heat and moisture resistance, and protection from welding arc and spatter.

Type 971 has lens holder molded into shield to eliminate light leaks and to further reduce weight. *Type 973* has lift front lens holder to permit operator to view, chip and clean weld without raising hood. Both shields are equipped with Federal Specification lens. Complete details on request.

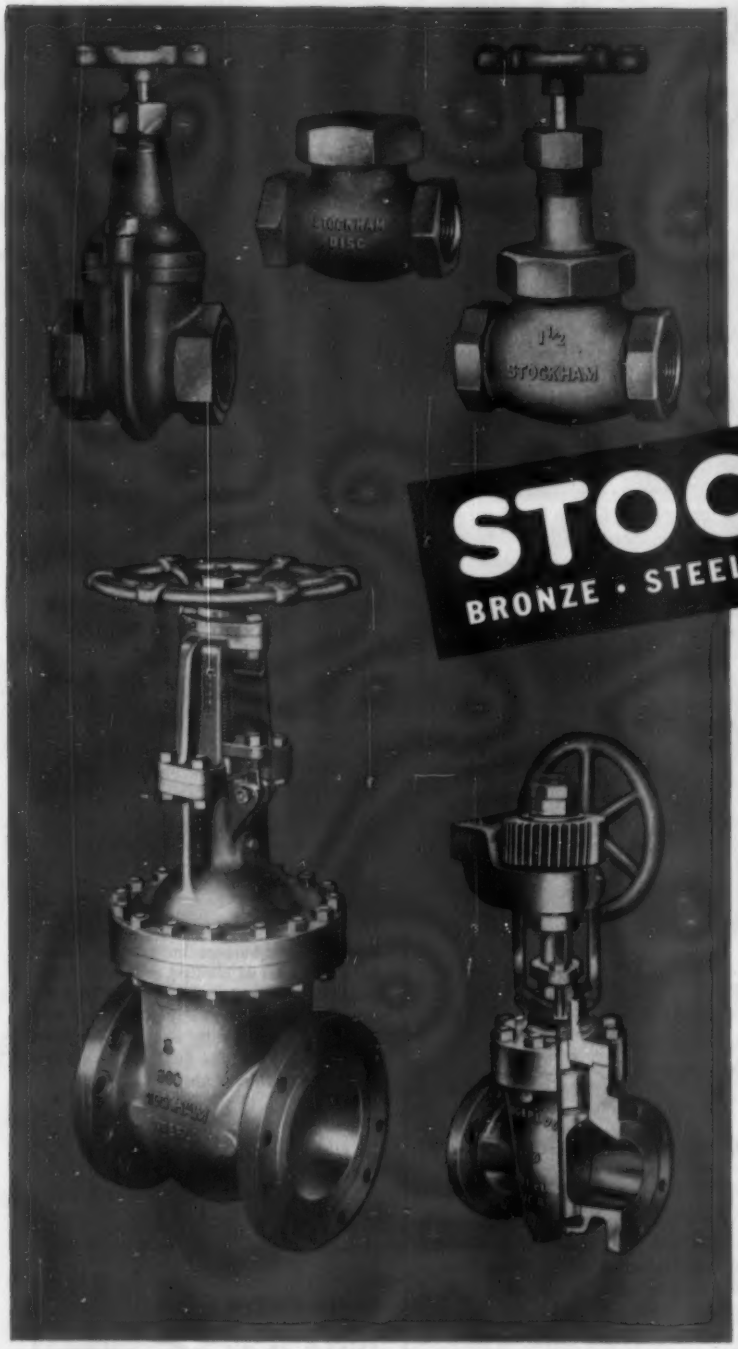
Hobart Bros Co, Troy, Ohio

For more data on these items, use post cards p 173. Identify your request with item number.

Heavy-duty limit switches

250 • *Series L100* switches, widely used for automating machine tools and conveyors, have been improved to provide 70 deg overtravel in either direction of the lever. Purpose is to facilitate faster installation by providing an additional safety factor and greater protection against switch breakage and damage. Increased overtravel is accomplished without use of cams, levers or extra springs. Full information available in manufacturer's *Loxswitch* catalog.

R B Denison Mfg Co, 102 St Clair Ave NW, Cleveland 13, Ohio



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THE MERCOID CORPORATION
4221 Belmont Ave., Chicago 41, Ill.

NUCLEAR FISSION

Continued from page 89

equal. U-235 splits up in more than 30 different ways—ranging from mass numbers of 72 (isotope of zinc) to 158 (isotope of samarium). Fig. 4 shows that the fragment masses fall into two broad groups, a "light" group with mass numbers from about 80 to 110, and a "heavy" group ranging from 125 to 155.

About 97% of the U-235 nuclei fragments fall into these two groups. A typical reaction for U-235 yields isotopes of strontium and xenon:

$$_{92}U^{235} + {}_{0}n^{1} \rightarrow {}_{38}Sr^{94} + {}_{54}Xe^{140} + 2{}_{0}n^{1}$$

About 6½% of the fissions follow this reaction, whereas only 0.01% of the nuclei undergoing fission break up somewhat more symmetrically. This is the experience with slow neutrons. With fast neutrons there seems to be a greater probability of symmetrical fission, so there is a less pronounced dip in the curve of Fig. 4.

Fission product radioactivity stems from their high neutron:proton ratio. This ratio is almost always outside the stability range (too much mass for their charge). Fig. 4 of Part 4 (p 108, Oct 1954, POWER) shows the stability range for the various elements. To reach stability the fragments emit negative beta particles, normally in chain fashion.

As an example, the decay chain for strontium is:

$$_{38}Sr^{94} \xrightarrow{\beta^-} {}_{39}Y^{94} \xrightarrow{\beta^-} {}_{40}Zr^{94} \text{ (stable)}$$

The decay chain for the companion fragment, xenon, is:

$$_{54}Xe^{140} \xrightarrow[16\ \text{sec}]{\beta^-} {}_{55}Cs^{140} \xrightarrow[66\ \text{sec}]{\beta^-} {}_{56}Ba^{140} \xrightarrow[12.8\ \text{days}]{\beta^-} {}_{57}La^{140} \xrightarrow[40\ \text{hr}]{\beta^-} {}_{58}Ce^{140} \text{ (stable)}$$

The stable end product for strontium is zirconium and for xenon it is cesium.

Gamma radiation quite often accompanies the beta-particle emission making the fission products extremely dangerous. Hence radiation shielding must be provided when handling fission products. The fission products must be removed periodically. They poison the fuel by their dilution effect and by wastefully absorbing neutrons. They are, however, a valuable source of radioactive nuclides which cannot be made by ordinary bombardment methods. Certain nuclides should have a very practical value in the future.

Next part of the nuclear energy study course will deal with the chain reaction —in a forthcoming issue.

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OIL BURNERS

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7 ADVANTAGES

in pulverized coal fired boilers . . .

They may be installed in practically all types of pulverized coal burners, with these seven important advantages:

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- They permit operation with oil or coal—whichever is available and lowest in cost per BTU.
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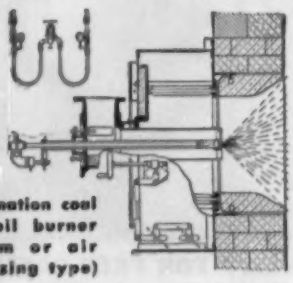
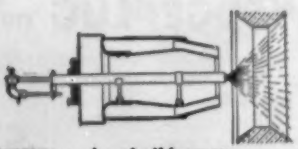
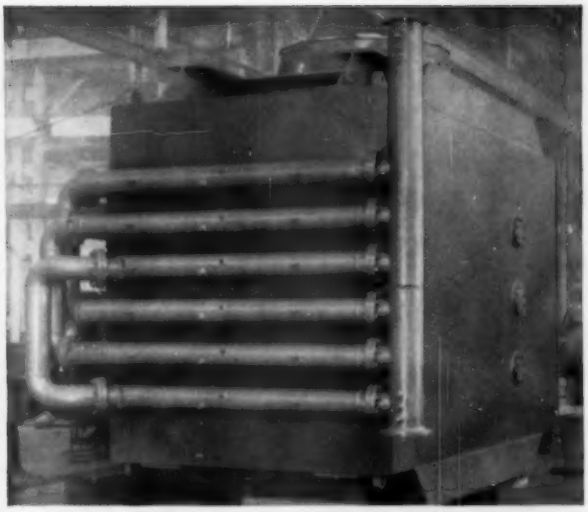


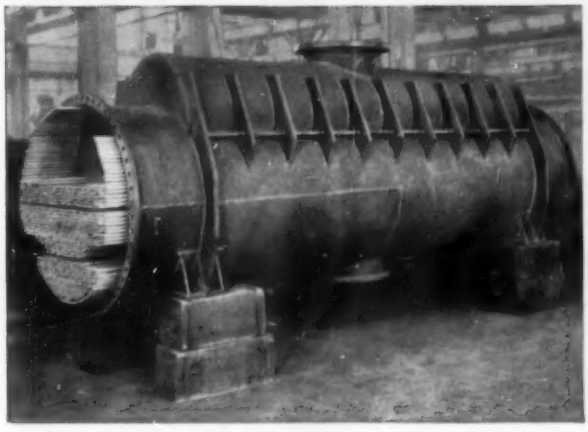
Combination coal and oil burner (Steam or air atomizing type)

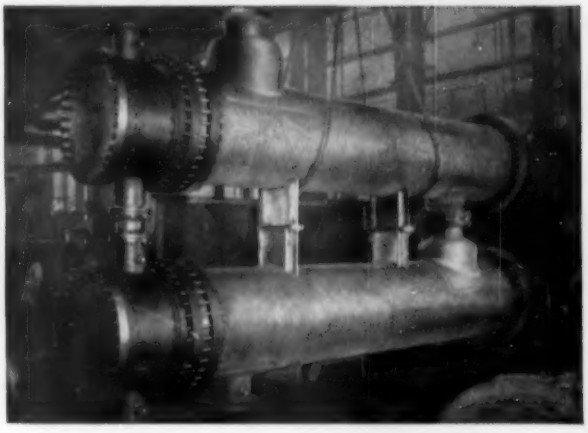


Combination coal and oil burner (Mechanical atomizing type)

Enco Burners







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Before you form your own opinion on how complex or specialized your condenser or exchanger has to be to meet your requirements, consult with a Kewanee-Ross engineering representative. A short talk can well result in many shortcuts to a satisfactory solution.

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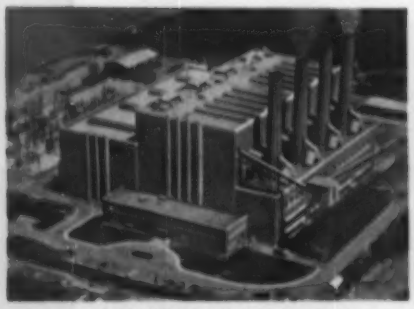

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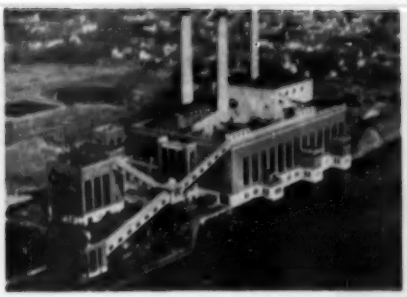
OSAGE HYDRO DEVELOPMENT

WANETA HYDRO DEVELOPMENT

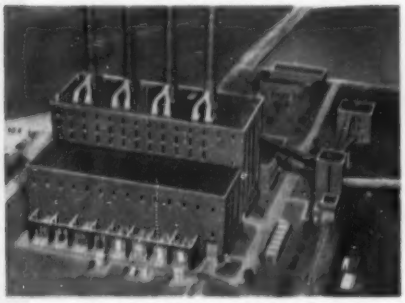
* ***EXPERIENCE:*** **Starting 65 years ago, the Corporation's work in the steam power field alone aggregates in excess of 11,300,000 kw in capacity, equivalent to about 16% of the utility steam generating capacity in the United States. Hydroelectric projects, with a capacity equal to about 10% of the present privately-owned hydroelectric capacity of the United States, also have been built by the Corporation.** ***These installations, both steam and hydro, have ranged from small industrial or utility installations to superpower stations.***

ETIWANDA STEAM STATION

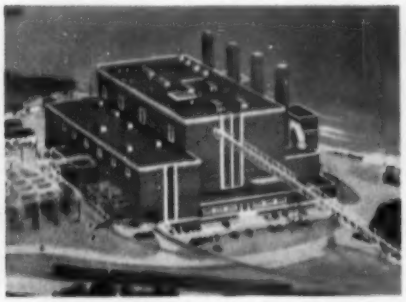
CHESTERFIELD POWER STATION



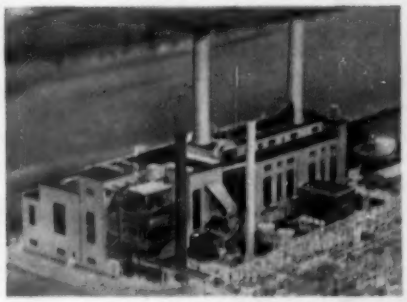
SOMERSET STATION



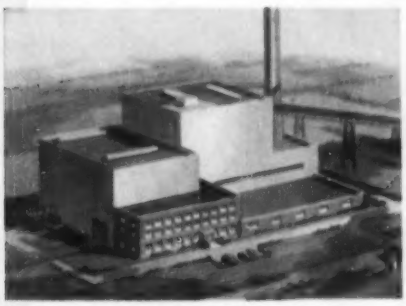
OSWEGO STEAM STATION



POTOMAC RIVER STATION



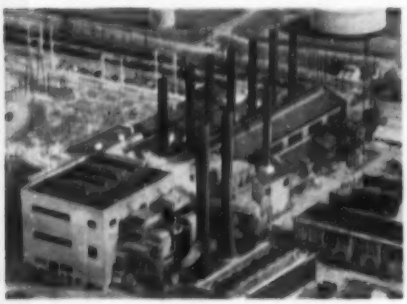
NECHES POWER STATION



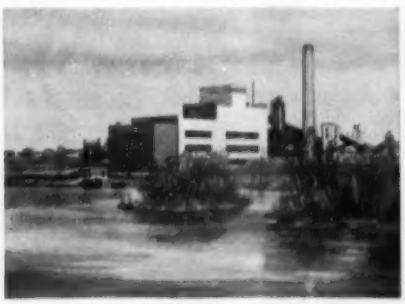
MIDDLETOWN STATION

ROCK ISLAND HYDRO PLANT

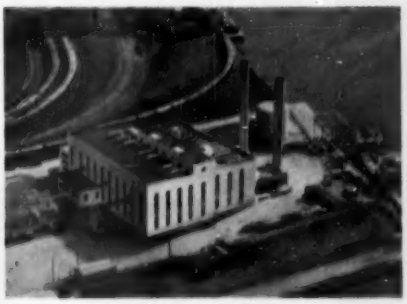
CARIBOU STEAM STATION



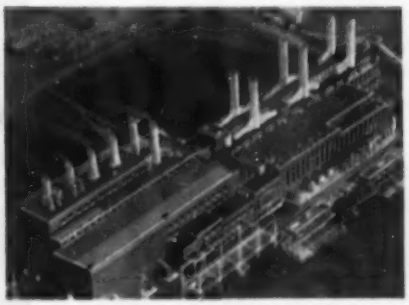
LOUISIANA STEAM STATION



SABROOKE POWER STATION

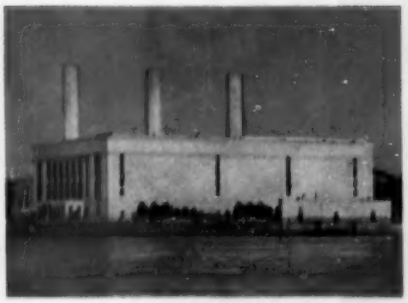


HOOKERS POINT STATION



HUNTLEY STEAM STATION

MOSS LANDING STATION



BUZZARDS POINT STATION

Representative illustrations taken from recent Engineering Corporation advertisements.

STONE & WEBSTER ENGINEERING CORPORATION

A SUBSIDIARY *of* STONE & WEBSTER, INC.

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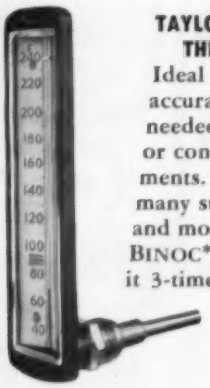
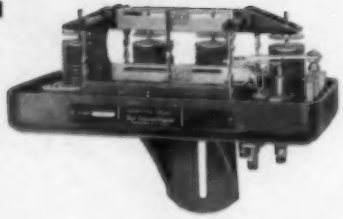
ranged from small industrial or utility installations to superpower stations.

The Company Treasurer will love them!



TAYLOR INDUSTRIAL THERMOMETER
Ideal wherever an accurate check is needed on recording or controlling instruments. Available in many standard ranges and mounting angles. BINOC* tubing makes it 3-times-easier-to-read.

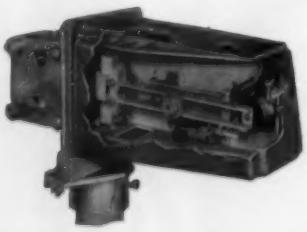


TRANSET* COMPUTING RELAY
A pneumatic, force-balance transmitter for adding, subtracting, averaging and ratioing. For intricate applications requiring close computing accuracy. Handles up to 3 separate pneumatic input pressures with an accuracy of .5%.

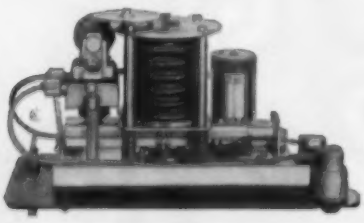
RECORDING FULSCOPE* CONTROLLER
For desuperheaters, or for any close, accurate control of temperature, pressure, flow or liquid level. Quickly adapted to operating requirements.

WHY? Because these Taylor instruments will help you increase operating efficiency and cut costs. That's enough to warm the heart of the coldest finance man. Of course, these are only a few of the complete line we can offer you for better measurement or control of temperature, pressure, flow or liquid level. Ask your Taylor Field Engineer! Taylor Instrument Companies, Rochester, N.Y., and Toronto, Canada.

NEW 6" DIAL INDICATOR
For temperature and pressure measurements. Has an all-new design movement for greater sensitivity on any type of measuring job. New case can be flush or face mounted, is fume and moisture proof. Big selection of standard ranges.



TAYLOR TRANSAIRE* DIFFERENTIAL PRESSURE TRANSMITTER
A rugged, dependable and accurate instrument designed to measure flow, liquid level or specific gravity. Taylor's latest addition to TRANSET System of transmitters, receivers and controllers.



TAYLOR TRANSAIRE TEMPERATURE TRANSMITTER
Compact and super-responsive. Designed to measure and transmit smallest temperature changes up to 1,000 feet with great accuracy. Provides dynamic accuracy, thanks to derivative action in the measuring circuit. Similar instruments for highly accurate pressure measurement.

*Reg. U.S. Pat. Off.

TAYLOR INSTRUMENTS MEAN ACCURACY FIRST

County Courthouse, Newkirk, Oklahoma

Where does the Court get its power?

For seven years in Newkirk, Oklahoma, one powerful machine controlled the power of the court... a Fulton 800 H.P. dual-fuel generating unit, lubricated by Cities Service Pacemaker #5 Oil.

But it wasn't only the court that depended upon this one machine . . . the entire town relied upon it. If the machine failed, so might the annual grain harvest, for Newkirk's grain elevators require great quantities of power.

BUT THE FULTON GENERATING UNIT AND CITIES SERVICE LUBRICATION PROVIDED FAULTLESS SERVICE. There was never a breakdown.

Newkirk's power boss, Superintendent of Utilities Ralph E. Cottrell, sums it up this way: "Using Pacemaker #5 in the engine's crankcase and cylinder lubricators, we not only enjoyed trouble-free operation during those seven years, but also surprisingly little wear and oil consumption. Rings, bearings and liners remained in top notch condition and the engine piled up well in excess of 6000 horsepower hours per gallon of oil."

This is but one more powerful story of Cities Service Lubrication . . . a graphic illustration of the kind of results you can expect from these highest quality lubricants. Why not get the whole story from a Cities Service Lubrication Engineer? Or write: Cities Service Oil Company, Sixty Wall Tower, New York 5, N. Y.

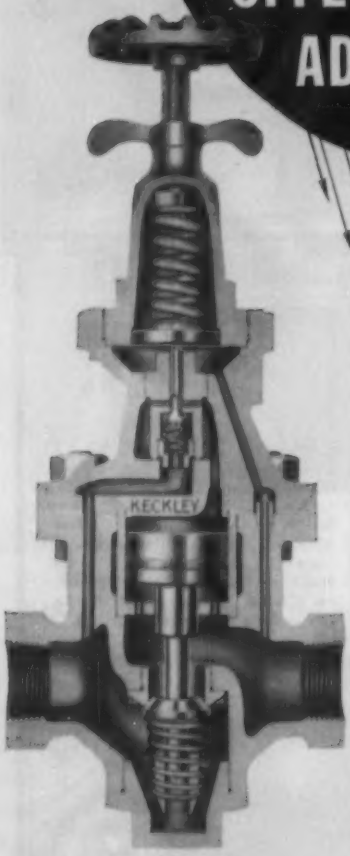
Ralph E. Cottrell, Power Boss of Newkirk, Oklahoma. All of Newkirk depends on him as Supt. of Utilities. He depends on Cities Service Lubricants for town's power generators.

Powerful Machine Behind The Court is this Fulton 800 H.P. dual-fuel generating unit. For seven years Newkirk's only major power source, it gave "faultless performance" using Cities Service Lubricants.

CITIES SERVICE

QUALITY PETROLEUM PRODUCTS

ONLY KECKLEY PRESSURE REGULATORS OFFER ALL THESE ADVANTAGES



Type AA Keckley Pressure Regulator

- Tested with steam for dead end service.
- No change of springs for different pressures.
- Stainless steel springs to insure long life.
- Phosphor bronze diaphragm.
- Stainless steel "unit pilot valve."
- Copper asbestos gaskets.
- Piston above flow, operation not affected by sediment.
- Bronze or monel renewable cylinder liner.
- Cast iron piston rings.
- Government bronze castings suitable for high temperatures.
- Stainless steel main valve and seat.
- Renewable features.
- No stuffing boxes, dash pots or weights.
- Guaranteed.
- Order one for test—no obligation.

Tested and approved—U. S. Navy for design · materials · workmanship and operation.

For complete details about all Keckley products, send for Catalog 54-A

O. C. KECKLEY COMPANY
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Pressure Regulators • Temperature Regulators • Float Valves
Strainers • Solenoid Valves • Reducing Valves
Pop Safety Valves • Relief Valves

KECKLEY CHICAGO

MARMADUKE

Continued from page 152

"After changing her name to the *USS Lejeune*, she was outfitted to carry 5000 troops. New boilers, turbines, reduction gears and roller bearings and auxiliaries were installed. One of her two stacks was removed and other face lifting done so even Hitler couldn't recognize her.

"The *Lejeune* made her trials and shakedown OK, then headed for New York to pick up troops, stores, and to join a convoy. But that's when trouble started. On the way up from Norfolk, No. 3 and 9 port roller-bearings and No. 5 starboard bearing heated badly. She was the only American ship with roller bearings on her drive shafts and caused plenty of excitement in the Bureau of Ships.

"Each bearing had two sets of rollers, inclined slightly for self-aligning. Now a 151-foot shaft expands and contracts plenty with temperature changes. To take care of that, the wide, single outside-race could slide in a fore and aft direction in its split cast-iron housing. Each race was a snug slide fit. A shallow sliding key on the bottom kept the outer race from revolving in the housing.

"Problem was why only a few of the bearings heated—and why only the after rollers and not the forward ones. The Swedish firm that replaced the bearings from the original German designs assured the Navy that the Germans had no such trouble.

"I was sent aboard as trouble shooter. Some of the Navy brass from Norfolk were aboard when I arrived. They had checked the drawings and were down below watching yard mechanics stick feelers in between the after-end rollers and races. But all the clearances were right on the cold bearings. The *Lejeune* had to sail with her 48-ship convoy and the Admiral in charge of repairs was also aboard, to see that she would get out on time.

"The Admiral and his gold-braided stooges completed their inspection without coming up with a solution. Then they went up to the ward room to take on ballast and throw around some high-powered theory as a smoke screen for not solving the problem. I stayed behind for a few minutes to get a look at one of the bearings that had heated.

"'What I can't understand,' one of the gold braid was saying when I got to the ward room to do a little refueling myself, 'is why only some of the bearings got hot. 'Why—'

"'In a loaded roller bearing, friction develops at the contact surfaces between the rolling bodies and raceways,' cut in the Admiral, as he hoisted a hunk of cake down his hatch and washed it down

ANKORFLEX PACKING SETS

Easy to install
Pressure range
50 to 2000 p.s.i.

ANKORFLEX Packings are fabricated to controlled dimensions to enable designers to proportion and detail packing glands and stuffing boxes to take a definite number of rings.

SUGGESTED APPLICATIONS

Ankorflex Automatic Packing sets should be applied to slow moving and intermittent moving rods and plungers such as accumulator rams, high pressure hydraulic press rams, valve stems, etc. These packings are not intended for use on fast moving or high speed rods or plungers in continuous operation.

These packings are especially suitable for operating cylinders, either hydraulic or air, on die-casting machinery, automatic grinding machines. By assembling sets so that pressure may act in both directions, double acting seals may be had.

TYPES TO ORDER

for steam or hot cases — Ankorflex 915-AR

for hot or cold water — Ankorflex 915-DR

for hot oil — Ankorflex 915-AN

for cold oil and gasoline — Ankorflex 915-DN

Upon request, we will be glad to send you a circular covering our Amflex 900 Heavy Duty "V" Type Packings.

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THE ANCHOR PACKING COMPANY

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FIBROUS AND METALLIC PACKINGS FOR EVERY INDUSTRIAL PURPOSE

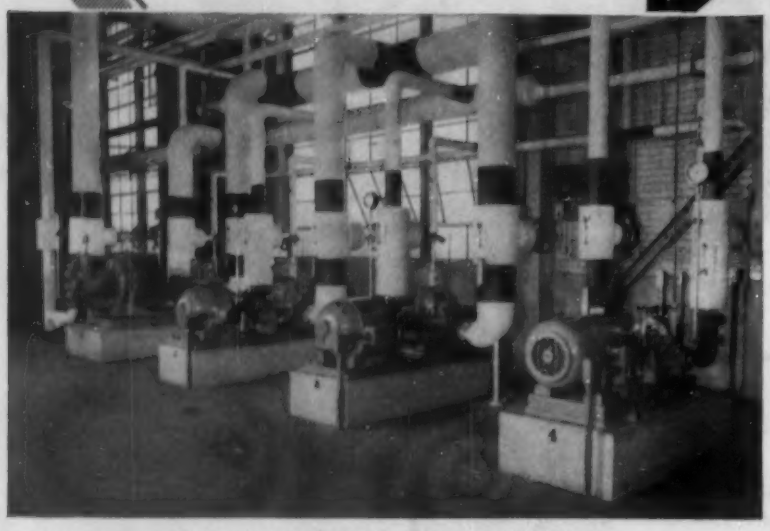
dependable

. . . or else!

Boiler Feed Pumps, like these four Warren Pumps shown at the new, ultra-modern North Grafton, Massachusetts, Heavy Press Forging plant of

WYMAN GORDON COMPANY

must always be available for round-the-clock operation—if and when necessary.



Photograph, courtesy Wyman Gordon Company. Other Warren Pumps in this plant include Condensate and Fuel Oil Transfer.

These experience-rated Warren Pumps, and thousands of others in the power plants of important and vital industries, are built with substantial plus factors as to dependability, low maintenance and economy.

BOILER FEED, CONDENSATE, FUEL OIL BURNER AND OIL TRANSFER SERVICE . . . there are types and sizes of Warren Pumps that will meet your requirements and live up to their reputation for dependability, minimum maintenance, economical operation and long life.

WARREN QUIMBY PUMPS

P-33

WARREN PUMPS

WARREN STEAM PUMP COMPANY, INC.

Warren, Massachusetts

MARMADUKE

Continued from page 196

with coffee. 'Don't forget that this friction is made up of a sliding resistance and a damping resistance,' he continued, trying to impress his audience.

"'During rolling, sliding takes place within a pressure area under molecular film lubrication. That is the molecular film adhering to the surface because of molecular forces and it has a lubricating action. The sliding resistance, therefore, does not follow the laws of hydrodynamics but is nearly independent of viscosity, speed of rotation and amount of lubricant.

"'Yes, Admiral, I agree with all that, but what—.' That's as far as a four-striper member of the brain trust got when the Admiral cut in again.

"'When starting a ball or roller bearing,' continued the Admiral, 'some dry friction must be overcome in areas where sliding takes place; therefore, the starting torque is somewhat higher than the rotating torque. In ball bearings, this increase is exceedingly small.'

"At this point the ship's chief engineer cut it, 'All that's very interesting, Admiral, but all we're trying to do is find why only some of the bearings heated, why they only heated on the after end, and how to correct the condition so we can join the convoy on time.'

"'If you ask me,' chimed in a young commander, who looked like he was just out of Annapolis, 'it looks like sabotage.'

"'As I was going to say,' barged in the Admiral without waiting for comments, 'I want those bearings that heated to be removed to our yard laboratory. Hook them up to a dynamometer and give them a life-endurance test by operating them to maintain their loading design limit.'

"'Drain the lube oil and check for oxidation stability, additive content and viscosity index. Then I want . . .'

"That was too much for me, so I shoved in my bow as politely as I could. 'BILGEWATER on sliding resistance, damping resistance, molecular film, the laws of hydrodynamics and all that test equipment. You don't have to remove a bearing to find out why it overheats. Just give me a boy scout's rusty penknife and a half hour's time.'

"That did it. The dozen or so high-powered officers in that ward room put down their refueling equipment as one man and stared at me. The Admiral's ears started turning red as two starboard running lights, then he got to arcing at the mouth. I guess no one ever crossed his bow before. Finally he blew his safeties and yelled, 'And who the hell are you and what do you know about roller bearings, may I ask?'

"'Sure, go ahead and ask,' I informed him. Then I started stowing away some

POWELL VALVES . . . THE COMPLETE QUALITY LINE . . . POWELL VALVES

POWELL VALVES THE COMPLETE QUALITY LINE

FIG. 1503—W.E. 150-Pound Cast Steel Gate Valve

FIG. 19084—900-Pound Pressure Seal Non-Return Globe Valve, Gear Operated

FIG. 3031—W.E. Cast Steel Globe Valve for 300 Pounds W.S.P.

FIG. 11365—Cast Steel Pressure Seal Horizontal Lift Check Valve for 1500 Pounds W.S.P.

. . . THE COMPLETE QUALITY LINE . . . POWELL VALVES . . . THE COMPLETE QUALITY LINE . . .

. . . THE COMPLETE QUALITY LINE . . . POWELL VALVES . . . THE COMPLETE QUALITY LINE . . .

POWELL VALVES . . . THE COMPLETE QUALITY LINE . . . POWELL VALVES

Investigate the many outstanding features of the High Pressure Boiler Non-Return Valve shown above (Fig. 19084). And be sure to find out about the *complete* line of Powell Valves —*quality* valves that will give you dependable flow control.

The valves shown above are examples of the many types of precision-built valves that carry the Powell name and measure up to the Powell standards of quality.

Consult your Powell Valve distributor. If none is near you, we'll be pleased to tell you about our complete line, and help solve any flow control problem you may have. Write . . .

The Wm. Powell Company, Cincinnati 22, Ohio . . . . . 109th year

YOU CAN DECREASE DOWNTIME TREMENDOUSLY

WITH R/M'S BIG 7 PACKING TYPES

R/M's Big 7 Packing Types make it easier for you to schedule downtime—go a long ways towards keeping it from being forced on you. Each of them is engineered to do specific jobs. Between them they can handle all but the very rarest packing applications. Most plants have found that they can meet their needs with just 3 or 4 of these packing types. And because they can, they've been able to cut investment costs, lower inventories, simplify ordering, and reduce errors due to faulty selection. To find out how you can get the same results for your plant, ask your R/M distributor for the R/M Big 7 Recommendation Chart.

R/M's BIG 7 PACKING TYPES MEET 95% OF ALL PACKING NEEDS

R/M Packings for maintenance purposes are sold only through authorized R/M distributors

R/M

BIG 7 PACKINGS

RAYBESTOS-MANHATTAN, INC.

PACKING DIVISION, MANHEIM, PA.

FACTORIES: Bridgeport, Conn.; Manheim, Pa.; No. Charleston, S.C.; Passaic, N.J.; Neenah, Wis.; Crawfordsville, Ind.; Peterborough, Ontario, Canada

RAYBESTOS-MANHATTAN, INC., Packings • Asbestos Textiles • Industrial Rubber, Engineered Plastic, and Sintered Metal Products • Abrasive and Diamond Wheels • Rubber Covered Equipment • Brake Linings • Brake Blocks Clutch Facings • Fan Belts • Radiator Hose • Bowling Balls

MARMADUKE

Continued from page 198

of the cake and pumping java into my deep tank.

"By then the Admiral's ears turned white—and so did his face. He was staring a hole through me and he looked like his generator would conk out any minute. Finally he sputtered, 'All right, godamit, I'm *asking*.'

" 'My name's Marmaduke Surfaceblow,' master mechanic from New York Navy Yard!' I informed him with great respect. 'But before I tell you what I know about roller bearings, I'd like to know what jackass was responsible for installing these bearings.'

" 'I was in charge,' roared a three-striper, jumping to his feet. Because it was our first experience with roller bearings, I had the yard men take every precaution so they'd run troublefree. I even had the bearing casing joints sealed with shellac so there would be no water leaking in or oil leaking out. Now go ahead and tell me what *you* know about roller bearings.'

"Everyone waited—I worked up a vacuum and took another swig of coffee. Then I lit up a piece of rope yarn and answered. 'Commander, I don't claim to know anything about anything. But you don't even have a problem. Just have your mechanics lift the covers off these four bearings that ran hot and scrape the shellac off the outer races where it squeezed out from the casing joints. Then next time the shafts expand and try to slide aft in the housing with their ball-bearing roller assembly, they won't heat on the after end. And when you get back to Norfolk, have your shellac-happy mechanics try drinking that stuff. It'll do less damage to them than to slap it on precision-built machinery like roller bearings.'

"For a minute no one said anything. Then the Admiral scratched his head and left the ward room, with his stooges in his wake. The ship's chief engineer came over to me and shook hands.

" 'By golly, Mr Surfaceblow,' he said, 'that's the first logical solution I've heard so far. We'll do as you suggest and I know that'll solve our problem.'

"An hour later the job was done and when the *Lejeune* shoved off next day with her convoy, those roller bearings gave no trouble because there was no shellac to keep the outer races from sliding with the shaft."—*SME*

Marmy's Mailbox

Marmy's yarn, "Mecanico Yankee En Una Planta Electrica," in August is wonderful. I wish to extend my congratulations for the rare flavor his stories add to the pages of POWER.

W R PENDER *New Orleans, La.*

He tests his purchases...

Do you?

Before he parts with $24.95, he tests a fishing rod to see how it will perform when the big ones strike. Yet last year, his department spent more than $100,000 for a cooling tower — and *nobody* has ever found out how it will perform under peak conditions!

Only a test will tell. The simplest and most positive test procedure is outlined in a new Marley technical publication, "Test Your Tower". By applying this conclusive test, you *know* the difference between actual and specified performance . . . you *know* how close your tower approaches the "guaranteed" performance you paid for.

With "Test Your Tower", a minimum of effort, and very little apparatus, you can determine performance of any industrial cooling tower under actual operating conditions. Just ask your Marley representative in any of 50 cities for your free copy, or mail the coupon below

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Please send me a copy of your new brochure, "Test Your Tower."

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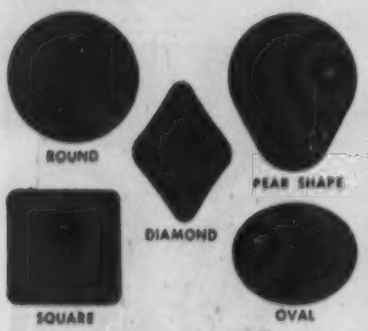
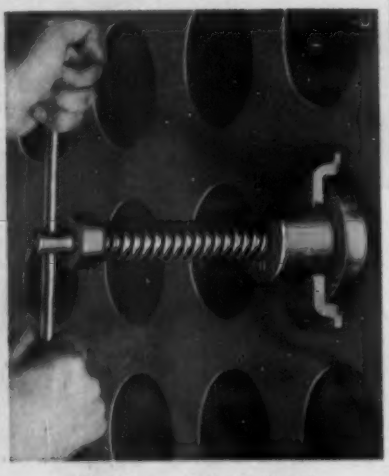
ROTO *Hand Hole* Seat Scraper

Eliminates Dirty, Tedious Work

Here is a simple, hand-operated tool for cleaning inside caps on boilers that will pay for itself many times over. This tool is equipped with retractable knives mounted on a revolving spindle having a bearing within a substantial yoke. An adjustable spring automatically maintains tension on the knives, sufficient to remove all foreign matter but not enough to cut the metal. A few turns to the right, and the job is done. A half turn to the left releases the tool. Try a Roto Seat Scraper and you'll wonder how you ever got along without one.

These are some of the hand hole shapes cleaned with a Roto Seat Scraper. Various sizes available.





Illustrating ease of operation of Roto Hand-hole Seat Scraper.

Roto Hand-hole Seat Scraper for B & W Boiler.

What Users Say—

It did a fine job. Completed the work in 80% less time.
(Engineer, Chemical Plant)

Roto Seat Scraper has paid for itself many times over on our Keeler Boiler.
(Supt., Public Utility)

One man cleaned inside cap seats on boiler header in 4 hours. Formerly took 2 men 3 days.
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BOILER AUXILIARIES

Continued from page 105

is prescribed by the pump manufacturer.

Check cooling-water lines for bearings, oil coolers or packing to see they are adequately supported independently of the main water lines. Shutoff valves must be located so lines can be shut off for dismantling one pump without affecting others.

Just before starting, check bearings for type and quantity of lubricant. Watch bearing temperatures closely, especially for the first few operating hours. If possible, run in the pump at light load before requiring it to supply firm feedwater to the boiler.

Set packing loosely when first starting, to permit ample water leakage for cooling packing and shaft. If necessary, hammer packing rings out slightly thinner to reduce friction in the gland and allow more water to leak out. Tighten packing gradually during operation until you have only a normal small leakage.

If there is a lantern ring in the packing assembly, it must be directly beneath the inlet for the lantern seal water.

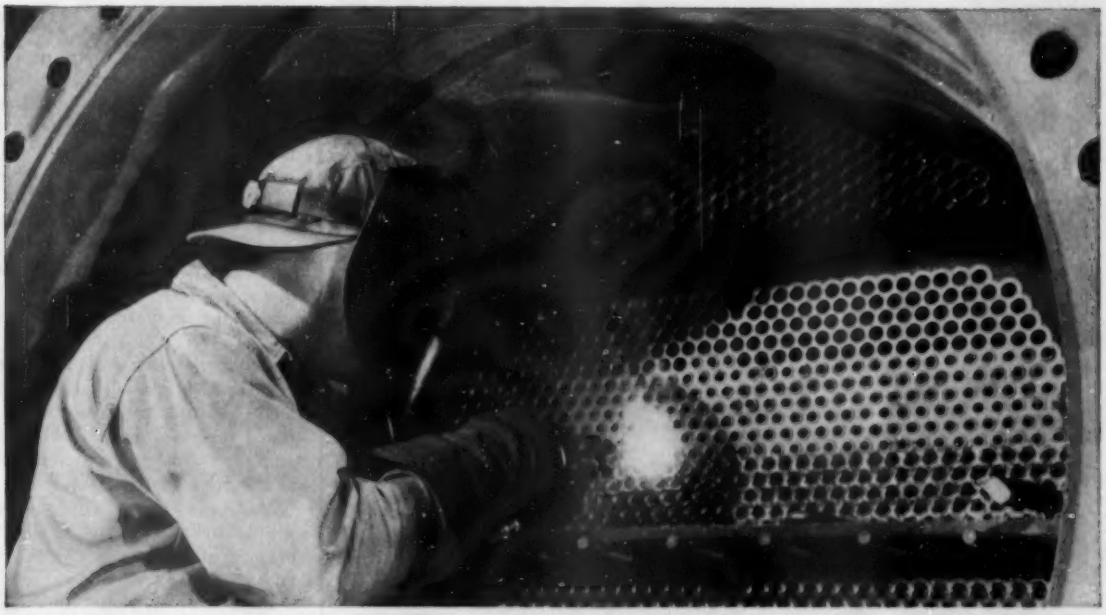
After pump operates a short time at normal temperatures, shut down and tighten casing bolts while unit is still hot. This may help prevent interstage and casing leaks and cutting.

As with most centrifugal pumps, best practice is to start the boiler feed pump with suction valve wide open and discharge valve closed or, at most, just cracked. Before shutting down, close off on the discharge valve if possible, particularly when pumps are operating in parallel. This avoids heavy impact of water on the discharge-line check valve. Be sure, of course, that recirculating line is wide open when pump is started or shut down.

Best test of a feed pump's condition is a continuing check of the total head it develops at a given load. Determine the original characteristics as soon as you reach normal operation so you'll have a standard for comparison.

If centrifugal pumps are not carefully designed and built, they often have a lower head at shutoff than when operating at 25 to 50% capacity. When two pumps operate in parallel at very low loads they may hunt. Then either hold flow above the point where hunting starts, or run only one pump at low loads. The manufacturer may be able to alter the impellers slightly to change the characteristics, if necessary.

Sometimes, through an accumulation of design margins in pump, piping, heaters, feedwater regulator and general equipment, discharge head of a constant speed pump is 20 to 50% higher than necessary. After allowing for 5 to 10%



A new technique. Using a 140 Monel electrode, welder joins tube ends to tube sheet by manual metal arc process. Monel-tubed high pressure heat exchangers constructed by this method give many years of trouble-free service. *Photo courtesy of The Lummus Company, New York.*

Welded-in tube design

minimizes maintenance in high pressure heaters

Today's technique of rolling feed-water heater tubes tightly into the tube sheet may soon be out-moded.

Using a method pioneered by Burns and Roe, Inc., New York consultants, The Lummus Company now builds exchangers with Monel® tubes *welded* in.

A primary advantage of the new method is that it has reduced the possibility of leaks at the tube sheet to a remarkable degree. One Mid-West municipal power plant, for example, has four of these welded Monel-tubed high pressure heaters. Two of them have been in service since 1946. None has given any trouble.

Of course, the success of the welded-in technique depends in large measure upon the tube material. It must join the tube sheet in a strong, sound weld. It must have high strength . . . good heat transfer properties . . . excellent resistance to corrosion.

Monel tubes qualify on every count. They are readily weldable, and fuse well with steel. Their high mechanical properties permit use of lighter gauges as a means of improving heat transfer. Their excellent resistance to corrosion extends exchanger life . . . reduces failures . . . cuts downtime.

And here's another desirable feature of Monel tubes — *in certain sizes they can now be drawn up to 85 feet in length.* Designers, therefore, can take advantage of longer tube bundles, and effect worthwhile economies by specifying heaters of *smaller* diameter.

Consider Monel the next time you design, install or re-tube a high pressure heater. Get full information now so you'll have it handy when the time comes. Write today for a free copy of our bulletin "Engineering Properties of Monel."

THE INTERNATIONAL NICKEL COMPANY, INC.
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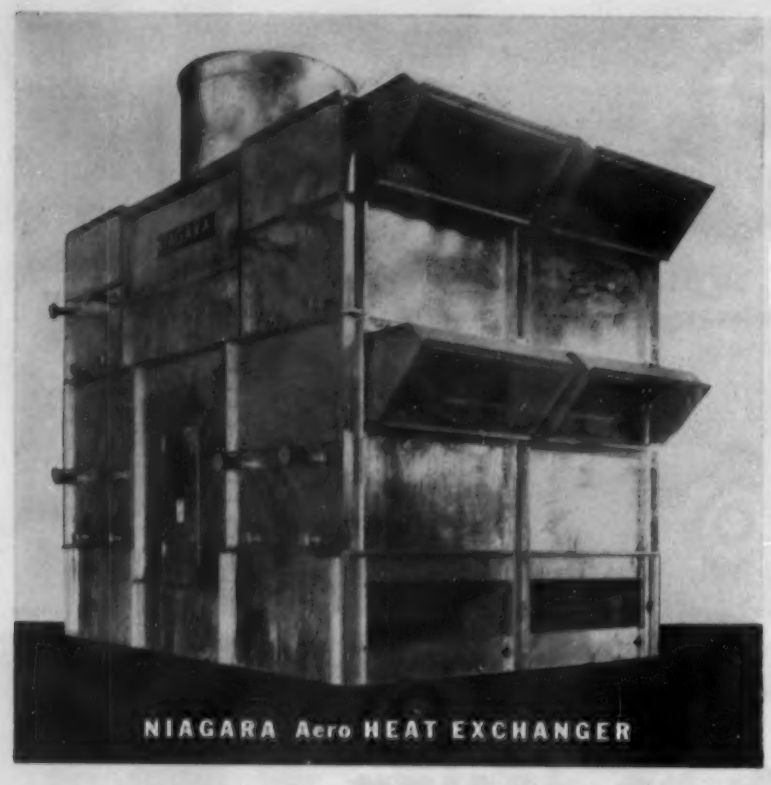

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Write for complete information; ask for Bulletins 120 and 124. Address Dept. P.

NIAGARA BLOWER COMPANY

405 Lexington Ave. New York 17, N. Y.

District Engineers in Principal Cities of United States and Canada

BOILER AUXILIARIES

Continued from page 202

drop in head because of pump wear, and for head droop characteristic that reduces available pressure at maximum flow, you may still have excess head.

Excess head requires extra power, and makes feedwater regulating valves work harder. Remedy may be to turn down the impeller diameters, or to remove one impeller from the pump to reduce the discharge head.

Pump drive through a hydraulic or electrical variable-speed coupling adds an extra rotating element. Take additional care in alignment. Follow manufacturer's instructions for installing and lubricating the coupling.

If drive is a steam turbine, keep steam supply and exhaust lines hot and well drained at all times so pump can run on a moment's notice.

Relief valve on the turbine casing warns against operating with the exhaust valve closed. This valve should open at a pressure below the safe limit for the casing. Before attaching steam piping to the turbine, blow out with steam. Put a strainer in the line to keep debris out.

Watch turbine bearings closely, as they will run hot. Temperatures to 160-180 F are OK if you use the proper oil.

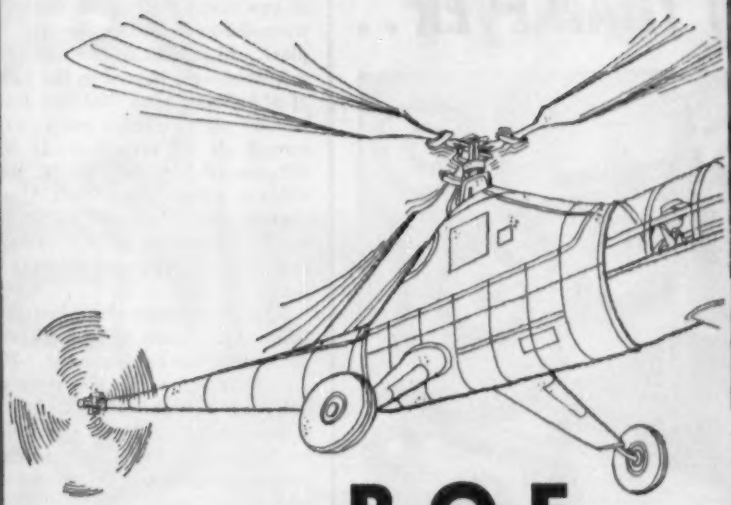
Clean and lubricate governors and safety stops or emergency trips so they work properly at all times. Turbine usually trips at 10% above rated speed. Check before running under load, and periodically thereafter.

The governor should control smoothly and without hunting. If feedwater pressure controls the turbine speed, piping arrangement should preclude possibility of a turbine runaway if pressure is cut off from the governor. The "feeler point" should be close to feedwater regulator inlet, and as centrally located as possible to all boilers.

Reciprocating steam-driven pumps need to be lined up carefully. Attach piping flexibly and without strain for conditions when system is hot, to avoid distorting the pump. Follow manufacturer's lubrication instructions carefully. But avoid excessive steam cylinder lubrication, especially if exhaust steam is used for feedwater heating. Put an oil separator in the exhaust line.

Reciprocating motor-driven pumps also require careful alignment and piping attachment. In addition, you need some form of relief or bypass valve to protect against discharge overpressure at low flows. If unit has an adjustable stroke mechanism, prepare it for service according to manufacturer's instructions to hold the desired discharge pressure regardless of the rate of flow.

Capsule Case History:



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by coupling 15 boilers to 16 turbo-generators in the largest private industrial power plant in the country. The interconnection of steam, feedwater and fuel supply lines as well as electrical circuits provides maximum flexibility in control, operation and maintenance.

The client is given complete security by the availability of a utility company tie-in to provide power for rapid start-up at the plant. Every KE designed plant has look-ahead features built in.

The new KE power brochure (No. 104) is just out. Your copy will be mailed upon request.

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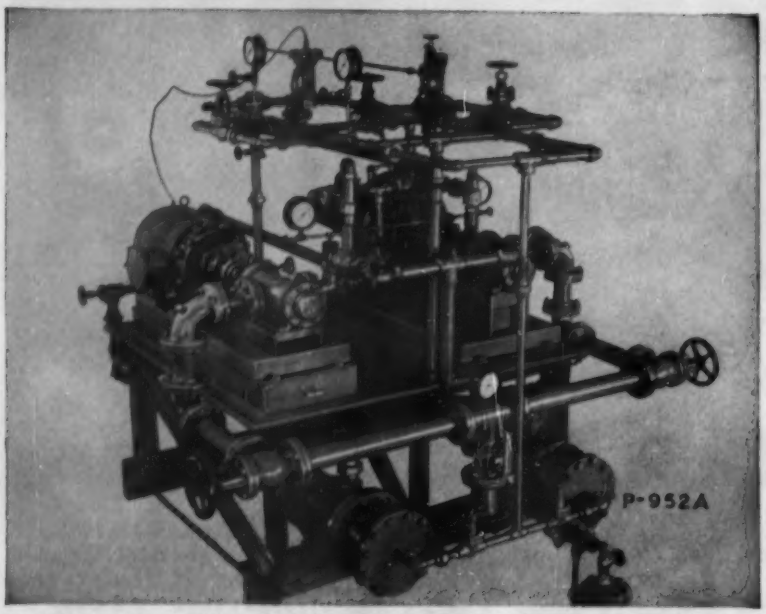

P-952A—Steam Turbine and Electric Motor drive gives flexibility in this compact Model P-852H size No. 25 unit.

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1954 AWARD WINNERS

Continued from page 106

tated that more reliable standby capacity be available. Existing system consisted of two motor-driven and one very old steam-driven machine in the power plant. In addition, two motor-driven machines were housed in the basement of a building some 300 feet from the power plant. This setup supplied enough air for present needs, but the old steam-driven unit was far from reliable as a standby machine. Also, compressors in the basement of the adjoining building were difficult to maintain and required separate operating attention.

New arrangement cleared north boiler room of all steam generators and set up a new compressor room. Hudson agreed to scrap the old steam-driven unit and buy a new 3000-cfm motor-driven compressor. At operating-floor level there are now four existing compressors and one new unit, motor-control centers and intake silencers. Receivers and aftercoolers are all in the new compressor-room basement. Height of the old boiler room far exceeds needs of the compressor room, but it supplies an abundance of natural light and ventilation as well as sufficient working area around all machines.

Electrical distribution was given a long hard look by BB&W engineers because modernization of this 4800-v system was a major problem. The plant had to remain in operation at all times with only minor changeovers permissible on weekends. And since old switchhouse equipment was obsolete, it had to be completely revamped.

Old system consisted of four generators and manual oil circuit breakers, operating on a radial bus. Powerhouse fed a primary switch house across the street through four 450-Mcm paper and lead feeder cables. Manually operated oil circuit breakers with about 25,000-kva interrupting capacity, in this switch house, were operated from a 2-position radial bus, permitting power to flow either from the powerhouse or from the local utility.

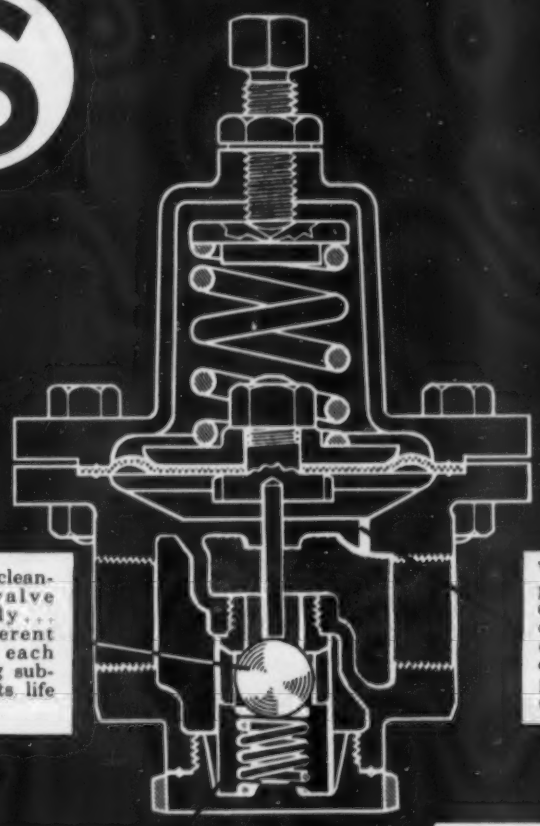
Using metalclad switchgear, engineers located a duplex panel, controlling all main circuit breakers, in the power plant. All breakers are now housed in primary switch rooms on a modified radial bus and have 250,000-kva interrupting capacity. System still permits synchronizing with the local utility company.

Other major changes include changeover of generator excitation from one common dc bus to individual exciters, and upping powerhouse secondary voltage from 220 to 440 by installation of a secondary unit substation.

THE LATEST CASH STANDARD VALVE

TYPE 1260

Direct Operated • Self Contained • Single Seat
Pressure Reducing and Regulating



Spherical self-cleaning inner valve rotates freely... seats in different positions at each closure, adding substantially to its life expectancy.

Velocity of gas or liquid passing the body port creates suction, thus reducing pressure in lower diaphragm chamber and opening valve wider to produce lower pressure drop.

New large area built-in strainer.

Available in aluminum, bronze, iron, steel or other specified materials.

WITH EXCLUSIVE DESIGN* for...

- Extremely LOW PRESSURE DROP and LOCKUP
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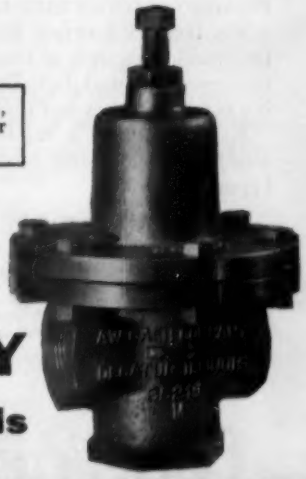

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Parkersburg Water Dept. reports LATTICE BRAID* *outlasts* previous pump packings $3\frac{1}{2}$ to 1

Below:
Centrifugal pumps at Parkersburg, W. Va., Water Dept.

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Only Garlock makes LATTICE BRAID rod and shaft packings.

The Water Department of the City of Parkersburg (W. Va.) has found that LATTICE BRAID pump packing has many advantages. Using LATTICE BRAID asbestos packing on their water pumps, they can pump 140 to 150 million gallons of water before the packing needs to be replaced. In terms of service life, LATTICE BRAID lasts for 12 months—$3\frac{1}{2}$ times longer than any previous packing. In addition, according to Ray Daniels, chemist at the Parkersburg Water Dept., LATTICE BRAID Packing needs very little adjusting *and* causes *no* wear on sleeves!

Put Garlock LATTICE BRAID Packing to work for your company. All the braided strands of this unique packing are lattice linked together into one structural unit. The strands hold together even when the packing is worn far beyond the limits of wear of ordinary braided packings.

LATTICE BRAID is made from flax, cotton, asbestos, wire-inserted asbestos, Teflon, and asbestos with Teflon impregnation—for various types of services.

Get all the facts about LATTICE BRAID *Packings. Contact your Garlock representative or write for new folder AD-131.*

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GARLOCK LATTICE BRAID PACKING

More PLANT PROBLEMS

Begins on page 140

Diesel cooling (cont from p 141)

CONSULT engine manufacturer before installing shutdown device on diesels connected in parallel. Throwing heavy load on one engine instantly, because the other has cut out, can cause severe damage to an engine.

To get more capacity, interconnect these towers at the basins, so that, with two engines running, 50% reserve cooling capacity is available.

We use alarms on high water temperature, purposely set 10 F below high limit. Water enters jackets at 140-150 F and goes out at 150-165 F. Cooling-tower water temperature varies with load, 80-90 F out, 90-100 F in. In cold weather a 3-way temperature-control valve quickly adjusts temperature by keeping bypassed warmer water circulating within above ranges. This keeps cylinder blocks from cracking because of sudden chilling.

Most new plants keep cooling-water temperature rise between 15 and 18 F. Water flow should be continuous and at uniform velocity to keep down engine hot spots and thermal stresses.

L W FITZPATRICK
Jefferson City, Mo.

RAW WATER USE for peak cooling periods can lead to scale of cylinder jackets. If this is the case, *FL* should retain a chemical-cleaning contractor to remove such scale.

Lube-oil cooling should also be checked. Lube oil removes some of the engine's heat, especially if pistons are oil cooled. If oil coolers operate on cooling-tower water, another solution would be to get a separate water source for it, thus relieving the cooling tower of some heat load.

Where a plant has full-time operators, I would not use an automatic shutdown device—especially if the engines are on a critical process load. But if *FL* feels he must have an automatic cutout, it should be set as high as possible above audible or visual alarms.

J H GRAHAM *Seattle, Wash.*

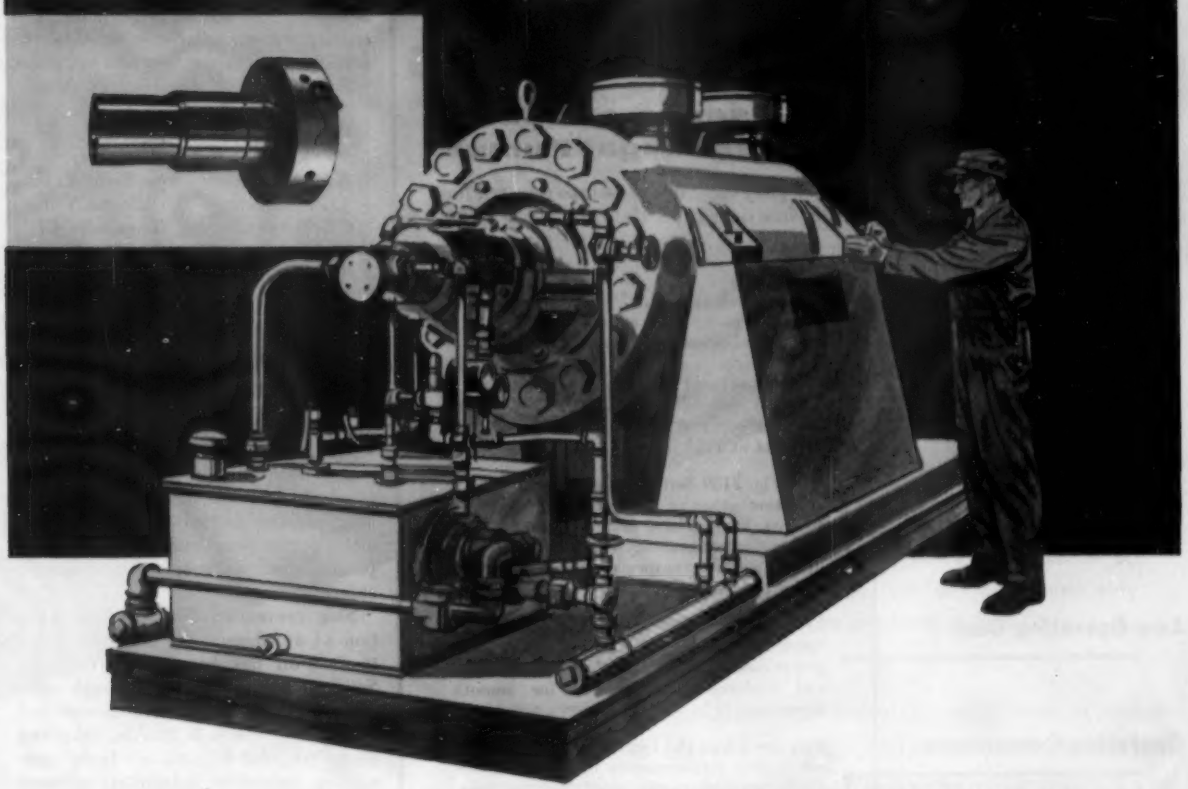
FAN mounted on a movable carriage, to take advantage of wind direction, improves heat transfer from cooling-tower water to air. Unit can be driven by a used automobile engine and V belt, to get large air volume at low speed.

If *FL's* cooling water has an algae condition (nearly always present at summer temperatures), eliminating it might pull him through. Any of the commercial chemicals, such as blue vitriol or chlorine, will do the job.

C G HOWARTER *Canton, Ill.*

(*Continued on page* 210)

Now... BJ mechanical seals for high pressure boiler feed pumps!



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- **No operating adjustment**
- **Stop liquid loss**
- **Reduce heat loss**
- **Save downtime costs**
- **Cut replacement costs**

BJ. the pacemaker in mechanical seals for pumps . . . now has pioneered the first successful application of the mechanical seal to high pressure boiler feed pumps. These new BJ Mechanical Seals are now in operation in a number of high pressure, hot water pumping operations, including temperature up to 430° F. These seals—some in service as long as three years—have paid off in performance. They have minimized heat and liquid loss, eliminated frequent repacking problems, and simplified maintenance since no operating adjustment is required. Find out how these new BJ Mechanical Seals for boiler feed pump service can benefit you. Contact your nearby Byron Jackson office or write.

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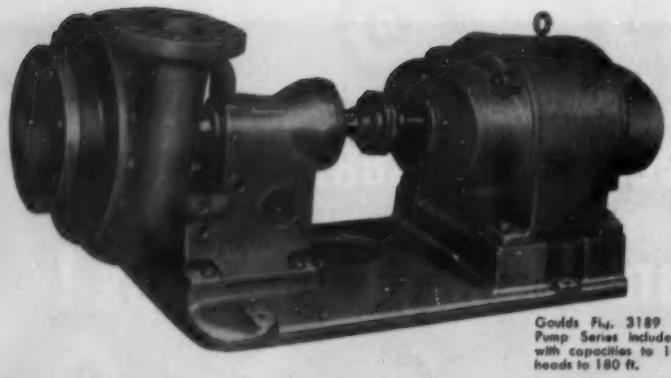

Goulds Fig. 3189 Centrifugal Pump Series includes 10 sizes with capacities to 1080 GPM; heads to 180 ft.

interesting facts

...about a new series of Goulds Multi-Purpose Centrifugal Pumps

Newest in a line of heavy-duty centrifugal pumps reputed for their dependable, trouble-free operation, the Goulds Fig. 3189 Series offers you:

Versatility — You can use the Fig. 3189 single-stage, open impeller pumps for general water service, irrigation, circulation, slurries, transfer, factory wastes and for air conditioning. You can choose just the right pump for your need from 10 sizes with capacities ranging up to 1080 gallons per minute, with heads up to 180 feet at 1750 RPM.

Economy — The Fig. 3189 Series is made in the Goulds tradition—they're built to work hard and to last long. Their design accommodates wide interchangeability of parts, greatly reducing parts inventory requirements where many pumps are used.

Low Operating Cost — Modern hydraulic design provides high operating efficiency with relatively low power consumption. Impellers are statically and hydraulically balanced for smooth operation.

Operating Convenience — You can adapt the Fig. 3189 pump to various piping arrangements by swiveling the discharge nozzle to any one of three positions.

Maintenance Convenience — Wide openings in the support head give ready access to gland and stuffing box. Bearing housing is completely sealed to exclude moisture and dirt. *You can safely use the unit outdoors without fear of dirt harming the bearings and you can hose it down without fear of water damage.*

For specifications, performance curves and other interesting design details that contribute to long, economical service, send for illustrated Bulletin 720.4.

MEMBER

Goulds PUMPS INC. Seneca Falls New York

ATLANTA • BOSTON • CHICAGO • HOUSTON • NEW YORK
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More PLANT PROBLEMS

Begins on page 140

CONNECT TOWERS so cooling effect is distributed equally to all three engines. Since they are probably not loaded equally, average water temperature would be lower than in an individual tower at peak load.

A temperature-control valve can be used to regulate engine temperature and give warning of overheating. But I recommend a simple temperature alarm and letting the operator decide whether to take the unit out of service. This plan is easier. And with a larger amount of cooling water available it shouldn't be necessary to change flow rate too often.

E A Roberts *Carlsbad, N. Mex.*

Other readers sending good answers, for which we lacked space, are:

A C Veen	*New York, N. Y.*
J C Ferrante	*Bronx, N. Y.*
C L Miller	*Metropolis, Ill.*
H Greiner	*Anoka, Minn.*
S O Scharf	*Long Island City, N. Y.*

CONTROLLED-VOLUME PUMPS

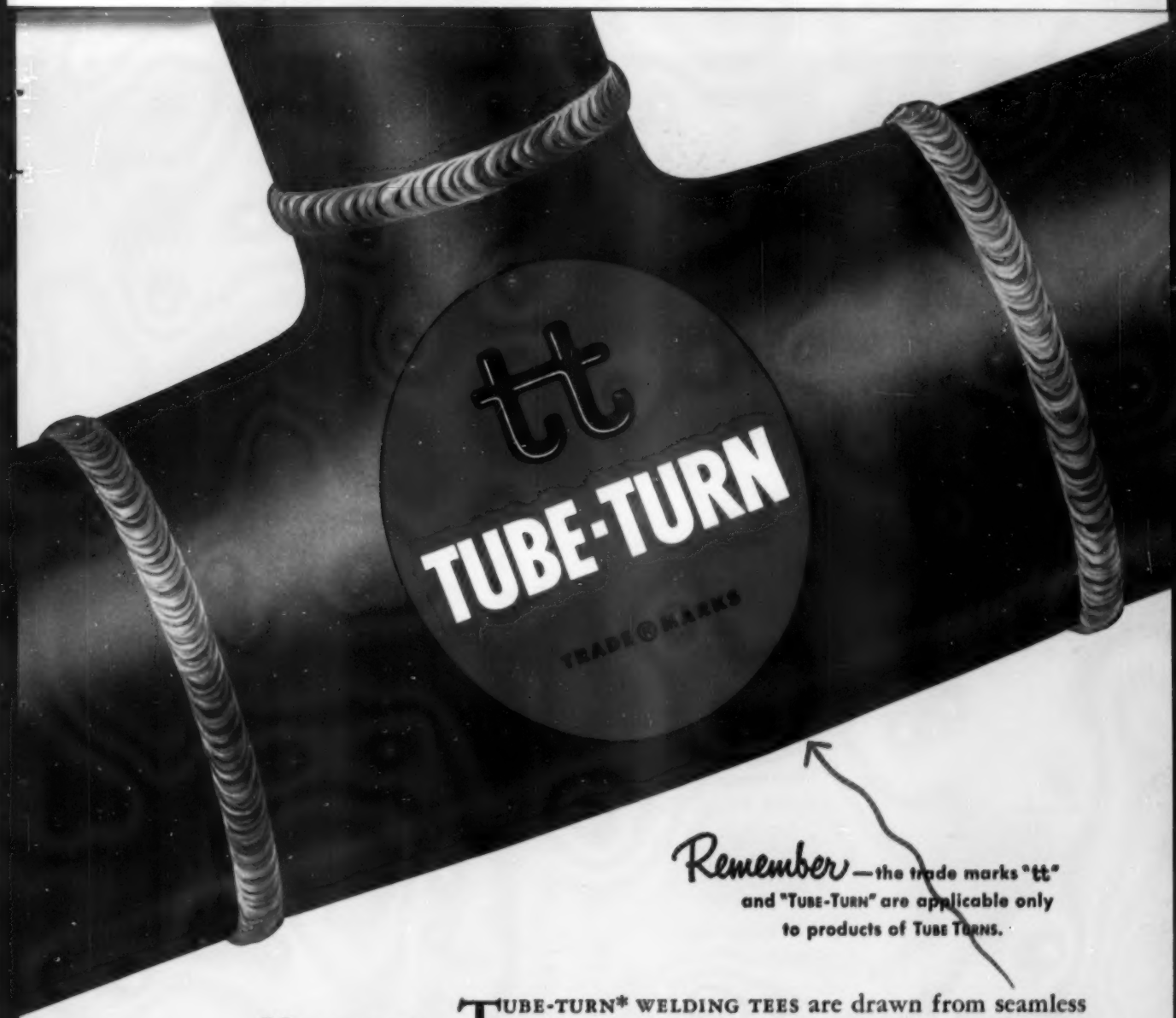
Continued from page 122

sheet in Fig. 12 shows the general installation pattern in each of seven stations this utility operates. Chemicals regularly handled include sodium sulfite, sodium hydroxides, neutralizing amines, trisodium and disodium phosphates, alum, sulfuric acid and sodium chloride.

Slag prevention by controlled addition of an alumina or dolomite slurry to fuel oil has been successful in a Southern utility, Fig. 13. Though some scale forms on furnace, superheater and air-heater tubes, it is friable, flaky and easily removed with an air lance, permitting operation indefinitely without shutdown.

Controlled-volume pumps, used as flow-control instruments, solve many other water-treatment and maintenance problems. Flocculating and activating agents are precisely controlled in coagulation systems. Inhibitor addition and pH control resist cooling-tower corrosion. Reagent addition, in solution or slurry form, is closely controlled to hot- and cold-process softeners. Desirable regeneration level is insured in ion-exchange resins and zeolites.

These pumps are the ideal adjunct to control valves for process control, since they are immune to the effects of viscosity or pressure-drop variations in the system. Two or more variables may be superimposed on one pump, maintaining the additive and main-line flow rates proportional, while varying the additive ratio as conditions require.



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TUBE-TURN* WELDING TEES are drawn from seamless tubing to a barrel shape. This, and other design features produce high strength—averaging over 25% more than required by applicable standards.

Specify TUBE-TURN Welding Fittings and Flanges for extra values: superior products, the exact fitting or flange you need from our complete line, outstanding engineering service. Call your nearby Tube Turns' Distributor. He is at your service!

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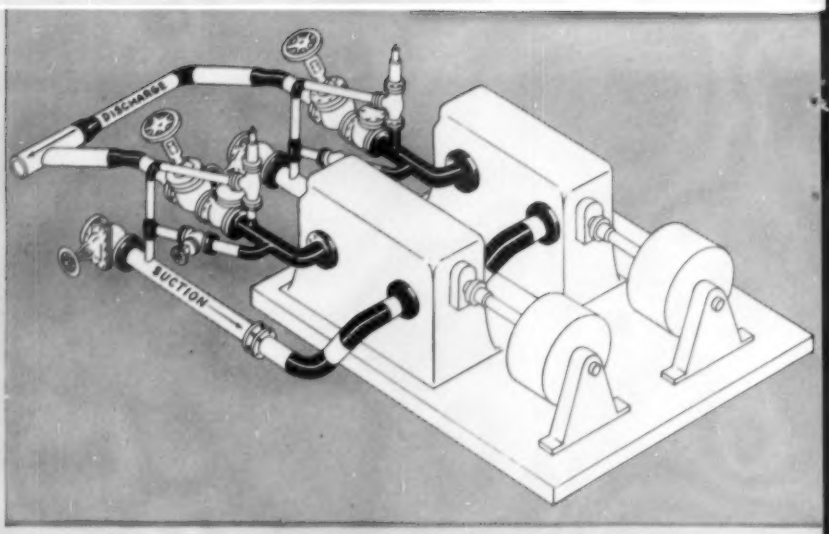
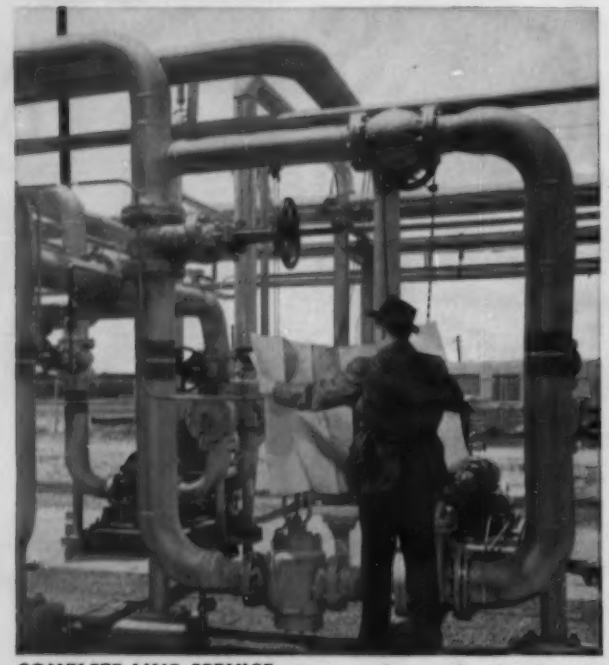


ENGINEERING SERVICE—Tube Turns' Engineering Service can help you on your piping projects. For example: Diagram above shows an application where TUBE-TURN* Welding Fittings and Flanges simplified the design and erection of pump piping. They save time, save space, and make the piping permanently leakproof and reliable. Ask your Tube Turns' Distributor to give you the pump piping recommendations of Engineering Service.



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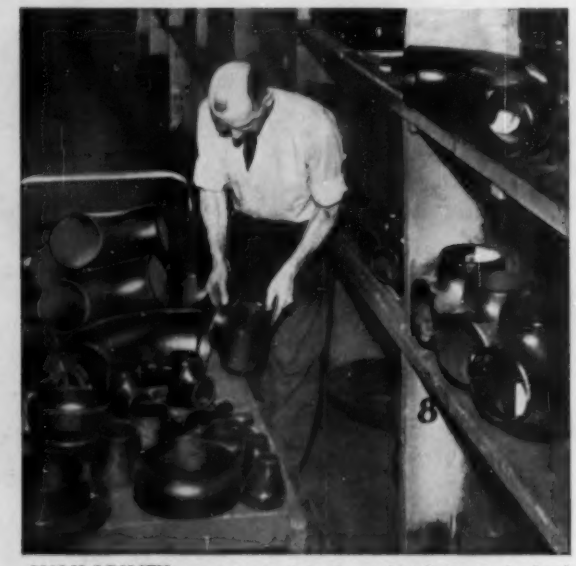

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Overall view showing Jeffrey decline conveyor leading from transfer point to Jeffrey Boom Storage Conveyor.

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Jeffrey Crusher for reducing oversize coal to the desired stoker size.

Incline belt in gallery to Poston bunkers.

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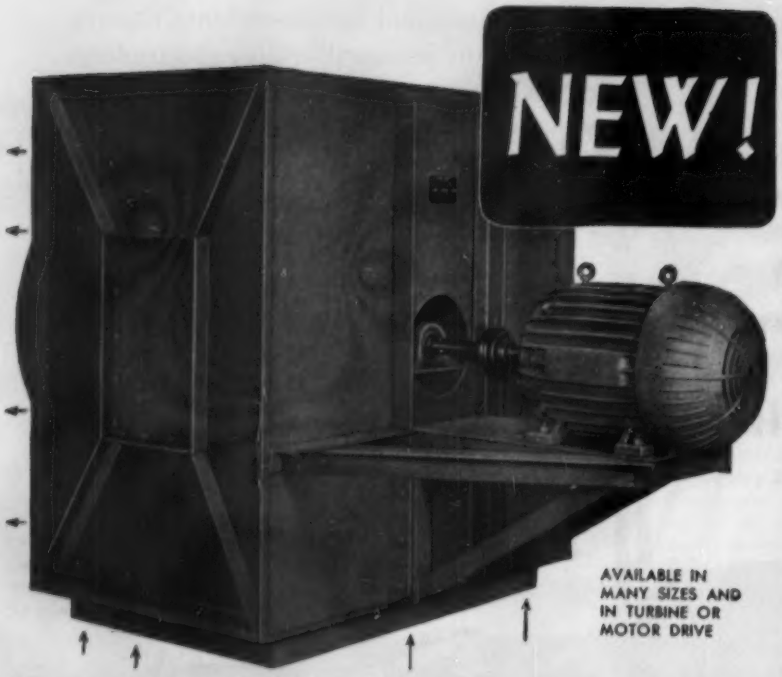

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WITH OUR READERS

Continued from page 5

show engineers here that the diesel principle was practical.

It was decided to send an American engineer to Germany to witness the building of the engine and to become thoroughly familiar with its theory, operation. As an engineer, I could have had the job, but without German I was unacceptable. At the time I was Col Meier's engineering assistant. On my recommendation a classmate of mine of German descent was chosen. The engine was exhibited in 1898.

Records of exhibitions held at the Mechanic's Building, Massachusetts Charitable Mechanic Association, reveal that "The 20th Exhibition was held from Oct 10 through Dec 3, 1898. The exhibit of a diesel motor (20 hp) was by Diesel Motor Company of America, 11 Broadway, New York, N. Y.

Comments by judges: "Exhibit was found of absorbing interest; demonstrating an entirely new departure in the generation of motive force, in economy and efficiency, far in advance of anything now in use."

What has become of this engine I do not know and have been unable to determine.

Windsor, Conn. E R FISH

EDITOR'S NOTE: *Considerable digging shows that the first commercial diesel built and run in the U.S. was a 2-cyl 4-cycle 60-hp air-injection unit based on designs by the Krupp engineers of Germany. It was built by the American Diesel Engine Co, founded by Busch, and installed in his St. Louis brewery in 1898. After running only a short time it was removed and destroyed.*

Early histories of the diesel do not state the exact installation date of this first engine. So we are faced with this question: Was the engine exhibited at Boston the first diesel to be seen in America, though admittedly not built here? Or was the Busch engine completed and running before Oct 10, 1898?

In line with this, Lou Rowley, Editor of POWER, *recently attended a dinner given for Dr Eugen Diesel, son of Dr Rudolph Diesel. Eugen Diesel recalled the 20-hp engine built and shipped to the U.S. for exhibition, but was unable to say if it was the first engine ever to operate in America. Perhaps but a few months separate the first revolutions turned by these engines. It would be interesting to find just which unit was the first to operate in the U.S. Can any reader supply additional facts on this milestone in the history of power generation?*

ARGUMENTS

Continued from page 146

Stoker-fired boilers are more responsive to changes in air supplied for combustion than to changes in the fuel-input rate. So I question need for automatically controlling stoker speed.

For a typical chain-grate stoker, average combustion rate is 30 to 35 lb per sq ft per hr, with maximum rate not over 45 to 60 lb. Do not exceed heat-release rates of 15,000 to 50,000 Btu per cu ft per hr.

High firing rates require thick fuel

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ARGUMENTS

Continued from page 214

beds, develop higher temperatures, cause faster burning and allow less time for the coal to burn to ash. Furnace is overloaded; grates and other parts exposed to combustion gas may overheat and burn out. Accumulation of ash beneath and in contact with the grates may cause overheating, while a thin layer of ash on top of the grates permits incoming air to cool the surfaces.

High volatile coals have free-burning characteristics and are suitable for forced-draft chain-grate stokers. These fuels burn with long flame, need large furnace volume. Overfire air assures full turbulence and allows a more uniform temperature distribution along the stoker.

Air pressure furnished by the forced-draft fans should vary in different compartments under the grates. The first or front compartment's air pressure should not exceed 2 in. wg, decreasing at rear of furnace where fuel-bed depth and air-flow resistance are less.

Traveling-grate stokers need a fuel-bed depth of 4 to 8 in., while underfeed stokers take 1 to 2½ ft. Combustion control should regulate height of coal bed, speed of grate travel and amount and distribution of combustion air.

H B WAYNE *Brooklyn, N. Y.*

UPSIDE-DOWN PUMP

Continued from page 86

the pump weight. We aimed to eliminate shims that may become dislodged and lost during a reinstallation. To do this, the sole plates were not grouted in until the pumps were completely assembled. This gives a proper fit at the centering ring joint without using shims under the base plate. If shims were lost during maintenance work, the pit would have to be dewatered to check the centering ring fit.

"Natural" arrangement. Design of power-plant equipment arrangement should not be forced, the "natural" one should be sought. There is no sacred or standard way or place to locate a unit of apparatus. Each piece depends on others and they all depend on their function and ease of operation and maintenance.

While plant designers are not equipment designers, they must be aware of allowable variations in equipment design. To depart from standard equipment usually costs more, but a designer can often pay more for a little extra to accomplish a greater over-all saving.

A "forced design" usually costs more to build and operate. It results from too much haste in choosing the final

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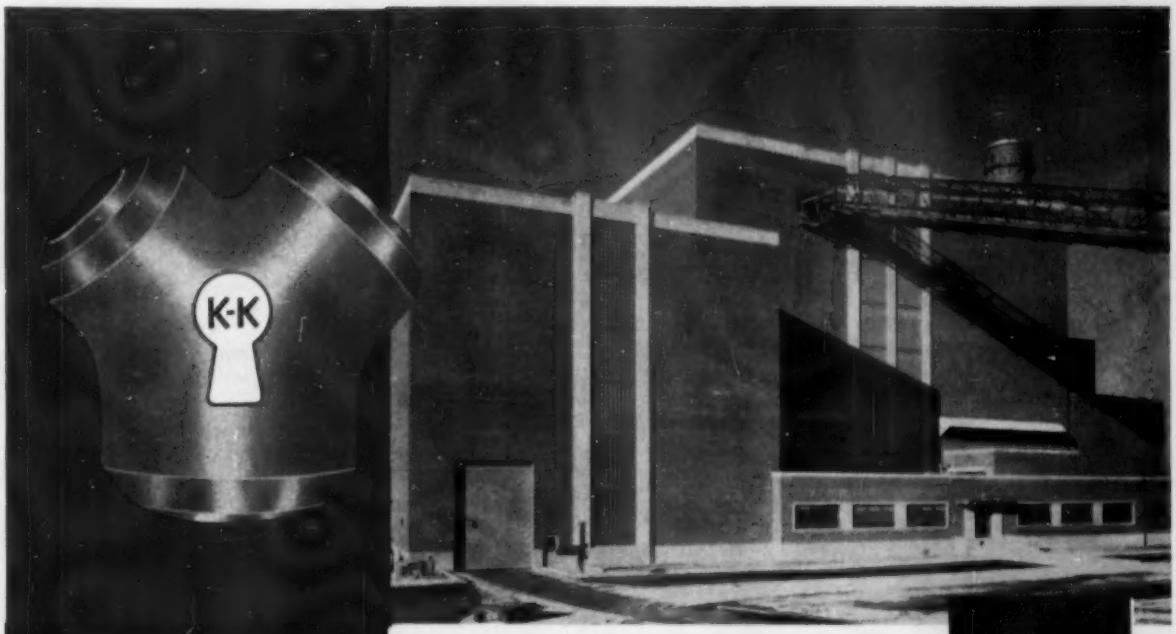

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serve main steam, hot reheat lines of new power plant

Insistence on unfailing strength and complete dependability was a major factor in Potomac Electric Power Company's selection of Key-Kast Alloy Welding "Y" Fittings for the main steam and hot reheat lines of its Potomac River Plant, Alexandria, Virginia.

These rugged Key-Kast fittings offer greater strength and longer life for power systems for these reasons:

- Increased structural strength, with greater wall thickness throughout
- Greater allowance against erosion, with extra thickness at critical areas
- Produced by most economical method
- Available in all shapes, sizes, schedules . . . in low and intermediate alloys and various stainless steels
- Meet A.S.M.E., A.S.T.M., A.S.A. Codes
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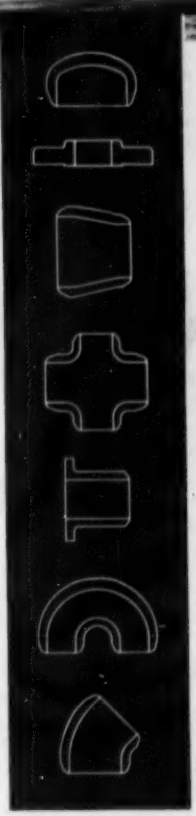

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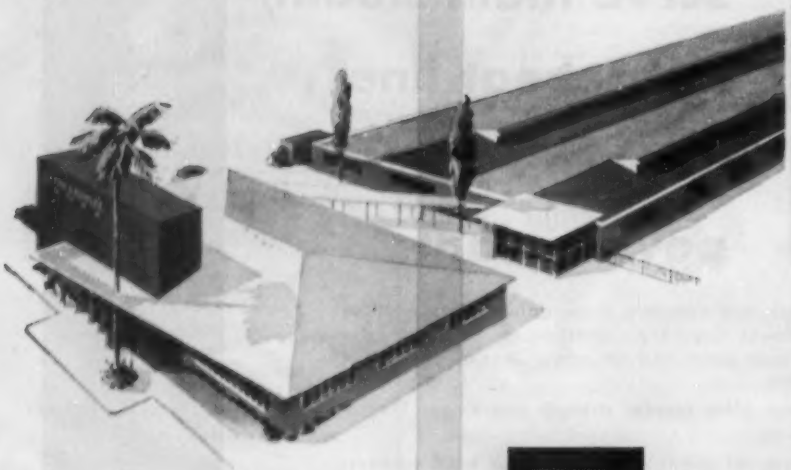

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UPSIDE-DOWN PUMP

Continued from page 216

arrangement and from preconceived notions about where things should be located. A "natural" design usually costs less to build, operate and maintain, but is more costly engineering-wise. It takes more time to "juggle" equipment to find the optimum arrangement. Better engineering always pays for itself, as we found with our upside-down pump.

BOILER ACCIDENTS

Continued from page 127

Hold water level fairly high just before taking boiler off the line. As load drops, water level drops. And as boiler cools, level drops further. If stop valves are closed too soon, heat of setting may cause safety valves to blow. This is sometimes controlled by bleeding off steam, blowing down boiler until level is near bottom of gage glass, then filling to top of glass with cool water.

Wait until boiler is cool when shutting down in preparing for inspection. Then blow out all water. Remove manhole and handhole plates and flush out all deposits unless otherwise directed by the inspector. Clean soot from firesides and clean furnace. Tag such valves as blowdown, stop and feed valves so they won't be accidentally opened with possible injury to workmen. Examine all surfaces for corrosion, scale or indications of overheating.

More TECHNICAL BRIEFS

Begins on page 160

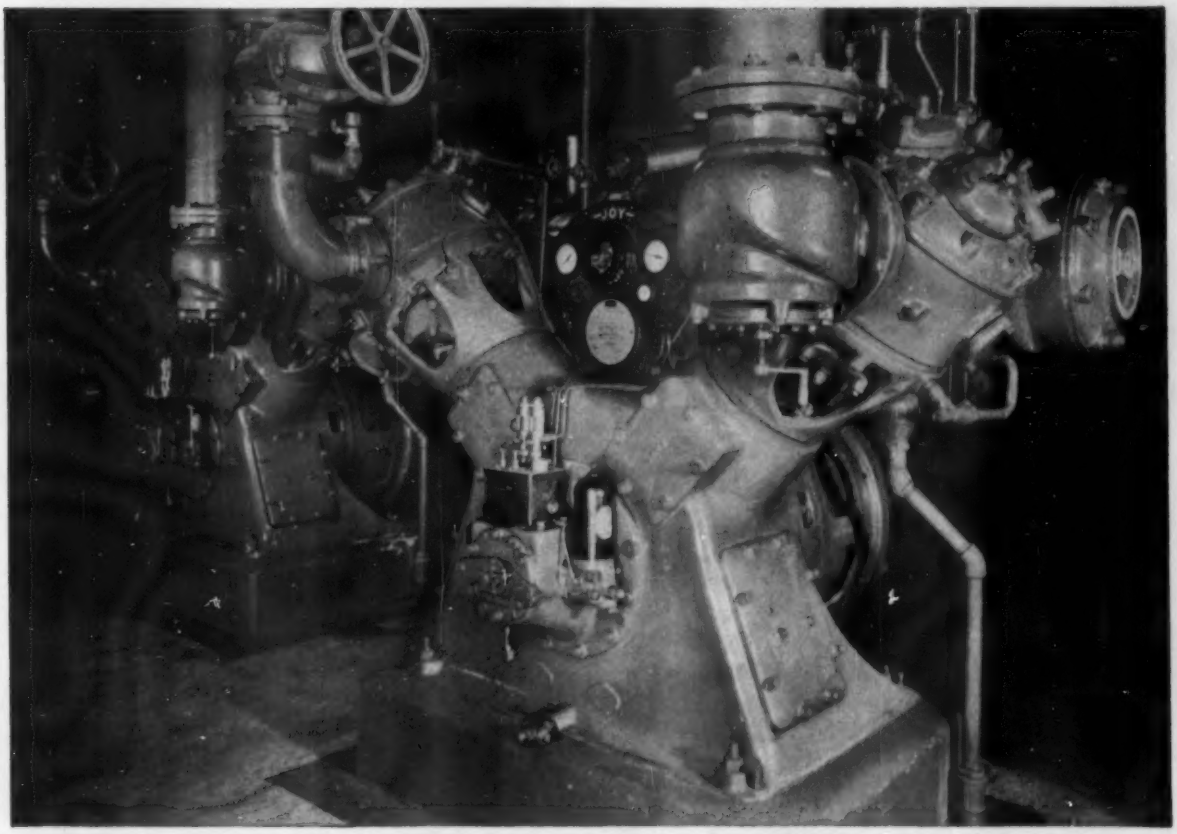
drum-metal temperatures in boiler operation. This apparatus may consist of baffle arrangements, devices that change direction of flow of a steam-water mixture as reversing hoods, separators employing a spinning action to remove water from the steam, steam purifiers like washers and screen driers.

These devices are used singly or in connection with others to remove impurities from steam delivered to the superheater. Primary objectives in design of drum internals are to assure delivery of pure steam to the superheater, produce uniform distribution of drum-metal temperature and to influence simplification of boiler design.

Drum internal design has had to keep pace with improvements in high-pressure high-capacity boilers. The trend in turbine design is toward higher cycle efficiencies. Full realization of potential savings will be obtained only if turbine blade deposits can be avoided.

The problem involved in production

Directions for ordering papers on p 226



The Case of the "GOOD AS NEW" COMPRESSORS

These two Joy WN-112 air compressors were used for several years in really heavy-duty operation under extremely tough conditions.

They were installed at different times . . . the newest about four years ago. Plant personnel report that, with nothing more than customary plant maintenance, they are still "good as new" and still furnishing, without shutdowns, the air to keep the plant in operation.

Durability and easy maintenance are built-in features of Joy WN-112 compressors. Cylinder and crosshead liners are field-replaceable, and made of alloy iron, honed to a mirror finish. Large area, low lift Joy "Dual Cushion" valves are set at the most efficient angle in both heads. Lubrication is by force-feed to all moving parts with automatic shut-off protection.

The Joy WN-112 is a heavy-duty, continuous service, two-stage, double-acting compressor of V-vertical design. It is normally powered by a flange-mounted motor but is adaptable to diesel, steam turbine, flexible coupling, V-belt or flat belt drive. It is a versatile machine and a compact space-saver in any plant.

For complete details on the Joy WN-112, write for Bulletin A-62 to ***Joy Manufacturing Company, Oliver Building, Pittsburgh 22, Pa.*** In Canada: *Joy Manufacturing Company (Canada) Limited, Galt, Ontario*

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- Two-position — opens damper wide, or closes it tight.
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More TECHNICAL BRIEFS

Begins on page 160

of steam to meet these higher standards has been accentuated by changing properties of water and steam in pressure ranges between 1500 psi and the critical point. *ASME paper no. 54-A-242.*

CO boiler and fluidized-bed steam superheater on Sinclair Refining Company's new fluid unit at the Houston refinery. *By O F Campbell and N E Pennels, Sinclair Refining Company.*

Approximately 400,000 lb per hr of 550-psig 750-F total temperature steam production is a unique feature of Sinclair Refining Company's new fluid catalytic-cracking unit at its Houston, Texas, refinery. Over 300,000 lb per hr of 700-psig saturated steam are produced on the oil industry's first direct-fired unit to recover both sensible heat and heat of combustion from high-temperature regenerator-exit flue gas.

Combustion heat of the gas is derived from its CO content. Saturated steam produced in the boiler is superheated to 750 F total temperature in industry's first fluidized-bed respray steam superheater. The superheater-respray feature produces approximately 100,000 lb per hr of additional steam and allows simultaneous control of both regenerator-bed temperature and steam superheat. *ASME paper no. 54-A-20.*

Power distribution

300-kv oil-filled cables for Aluminum Company of Canada. *By A N Arman, Pirelli-General Cable Works, Ltd.*

The main details of the Kemano-Kitimat transmission project of the Aluminum Company of Canada are well known by most engineers. High-voltage cables capable of conveying a minimum load of 550 amperes at 300 kv were required. The 3-phase power supply comes from an underground water-power station and goes through an overhead line to the electrolytic refining plant about 50 miles away.

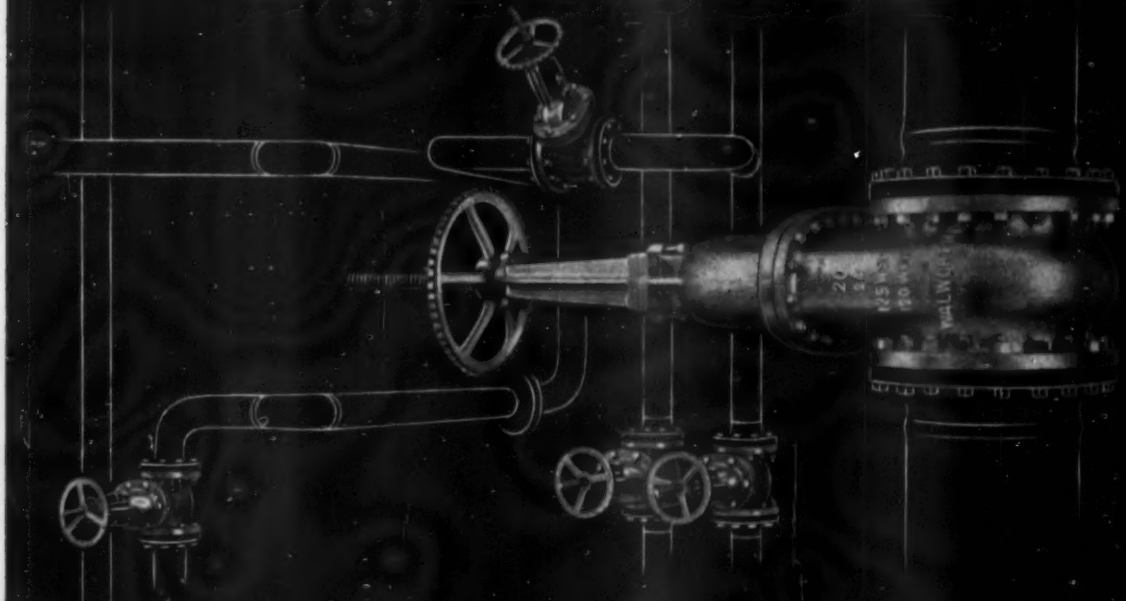
The cables discussed in this paper run between the power station and the overhead line. They are laid on racks at the side of a tunnel that slopes downward from the underground transformer chamber, the difference in levels between the ends being about 36 ft. Total length of cable route is 670 yd.

At the time of receiving the inquiry, few cables had ever been constructed for voltages of this order. It was clear from the beginning that very high stressing of insulation would be necessary to produce a cable of reasonable dimensions and cost.

Oil-filled cables had been supplied

Directions for ordering papers on p 226

WALWORTH



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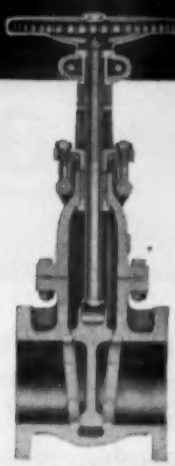
A wide range of Walworth Iron Body Wedge Gate Valves is available—through your Walworth Distributor—from which you can choose the right type to meet your most exacting conditions. Saddle-type valves as small as ¼-inch; low pressure valves for water and gas pipelines up to 36 inches.

Whenever you need valves and fittings, choose from complete lines—in a variety of metals—manufactured by Walworth. For more information, see your Walworth Distributor or write: Walworth Company, General Offices, 60 East 42nd Street, New York 17, N. Y.



Walworth No. 726F OS&Y (Outside Screw and Yoke) Iron Body Wedge Gate Valve. OS&Y valves are recommended for services where it is desirable that the line fluid does not come in contact with the stem threads. Note the swing-type gland-eye-bolts for easy repacking. Sizes 2 to 30 inches.

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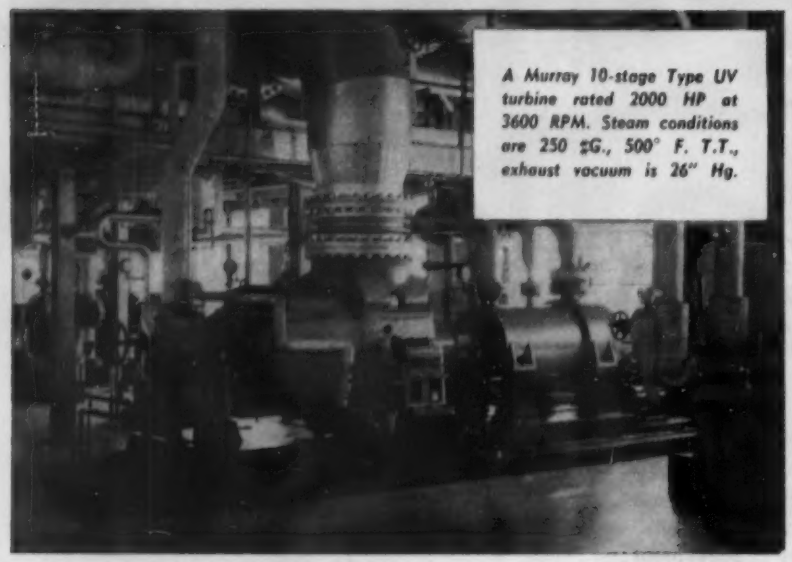

A Murray 10-stage Type UV turbine rated 2000 HP at 3600 RPM. Steam conditions are 250 #G., 500° F. T.T., exhaust vacuum is 26" Hg.

● The Murray Type UV turbine pictured above has been driving a high pressure lean oil pump in a Southwestern refinery for the past 10 years. And is still giving dependable, trouble-free service.

Murray mechanical drive turbines both single and multi-stage can be furnished in a wide range of ratings for steam pressures ranging from 0 to 600 #G., condensing and non-condensing. Types in the higher pressures available for up to 250 #G. back pressure.

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More TECHNICAL BRIEFS

Begins on page 160

for maximum working stresses of 228 volts per mil (90 kv per cm) and some gas-pressure cables had been in use at somewhat higher stresses, but for 300-kv working, still higher stressing became essential. From previous experience of oil-filled cables, it was decided that a maximum working stress of 305 volts per mil (120 kv per cm) would be feasible provided a dielectric of nearly perfect quality could be ensured. Design and development was started on this basis.

As this was the first contract for cables of this voltage ever made in the factory, the opportunity was taken of extending tests well beyond those actually specified to gain some knowledge of the margin of safety. All components gave highly satisfactory performance even when tested at stresses well above specification and at conductor temperatures at or above those for which the installation was designed. *AIEE paper no. 54-232.*

Current distribution in paired-phase bus bars under unbalanced load conditions. *By J B Cataldo and N Shackman, Bull Dog Electric Products Co.*

In a paired-phase multiple bus bar arrangement, currents in paired bars distribute themselves essentially equal in magnitude and opposite in phase under all conditions of balanced, unbalanced, transient, and steady-state loads. Minimized or almost complete cancellation of magnetic fields is therefore obtained.

A tendency exists for phase currents to equalize themselves among bus bars for conditions of unbalanced load. A consequent decrease and more uniform temperature rise in the bars, removal of hot spots, and a wider safety margin for overload conditions is obtained.

Use of interphase ties at load connecting points in a feeder system is necessary to obtain a more uniform division of current among all bars, low wattage loss, and more uniform bar temperature rise. *AIEE paper no. 54-329.*

Hydro development

Austria's experiences in international hydroelectric developments. *By Erwin Urban and Oscar Vas.*

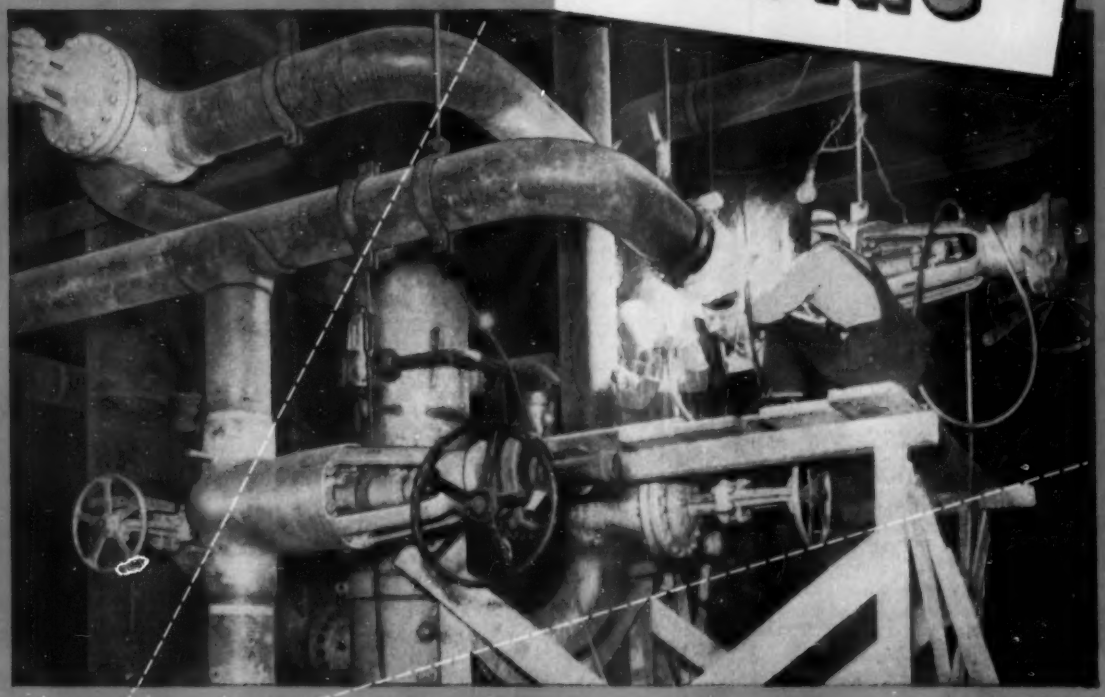
Discussion of legal and economic problems arising from utilization of water power of rivers running through or bordering two or several states have intensified with the progressing exploitation of hydro power.

Two opposite principles from the core of these discussions: The territorial principle, according to which any

Directions for ordering papers on p 226

THERE IS

MUCH MORE TO MIDWEST PIPING



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Here you see carefully qualified Midwest welders erecting the boiler feed piping in a new public utility steam-electric generating station. What you don't see are the many other highly skilled men who contribute to the high quality of Midwest Piping.

First, there are the expert piping engineers who prepare the job for fabrication. They simplify the field work and make sure the difficult operations are done in the shop. And they often make suggestions that improve the design and reduce the cost of the piping.

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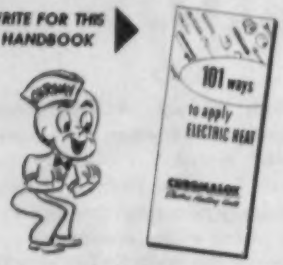

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More TECHNICAL BRIEFS

Begins on page 160

country, by virtue of its unlimited sovereign rights, was entitled to exploit the section of a watercourse within its territory without regard to any detriment inflicted thereby on other countries, and the principle of integrity where any country must, even on its sovereign territory, abstain from any interference in the natural flow of watercourses that prejudices interests of another state.

To an ever increasing degree, Austria and her neighbors have realized that rigid adherence to either principle would not promote their relations in the field of water economy.

Positive results have been obtained by cooperating with neighbor states in establishment of joint power plants. Today the concept of joint optimum utilization is being accepted to a greater degree. *WPC paper; no number.*

Steam power as a supplement to water power in Sweden. *By Folke Petri and Lars Lingstrand.*

Sweden's power supply is based almost entirely on hydro plants. While steam does not play too important a part, it is, nevertheless, a necessary complement if water power is to be harnessed to best economic advantage.

Steam power stations act as standbys when there is a capacity shortage, and as basic stations when there is an energy shortage. They are also useful as reserve stations in event of breakdowns. Since power additions are made in fairly large increments, steam stations can be incorporated in development schemes for hydro stations when output cannot be adequately adjusted to a continuously increasing load. They are also used for voltage regulation and for improving distribution stability.

The country's hydro resources are limited and can be expected to be fully utilized by about 1975. Load increases from then on must be taken by thermal power. It will be necessary to make continuous use of thermal stations for base loads while hydro handles peaks. Greater consideration must be given to efficiency of steam stations for this service. *WPC paper; no number.*

Water treatment

Boilers and boiler waters; interlocking advances in design. *By H M Rivers and S R Osborne, Hall Laboratories, Incorporated.*

The past three decades have witnessed many major advances in the field of steam generation. Boiler makers have provided industry with new and

Directions for ordering papers on p 226

Sperry Gyroscope Co. Operates 12 Test Boxes with

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Refrigeration

At the Great Neck, Long Island, plant of Sperry Co., a dozen environmental test chambers have been equipped with cooling and humidity control, operated by an elaborate low-temperature refrigerating system. This was designed and installed by Tenney Engineering, Inc., Union, N. J., using 14 Frick "ECLIPSE" compressors. Temperatures range from 100° below zero to 200° above.

Whatever your special cooling needs, there's a Frick air conditioning or refrigerating system to meet them with dependability. Let us submit an estimate: write, wire or phone—

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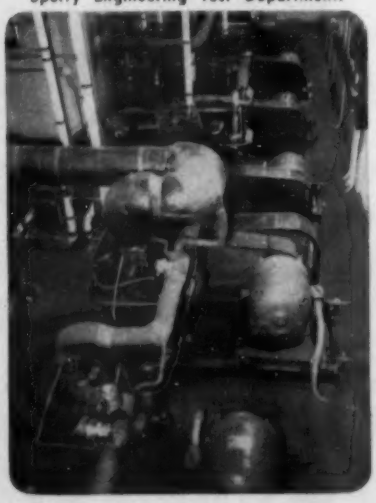
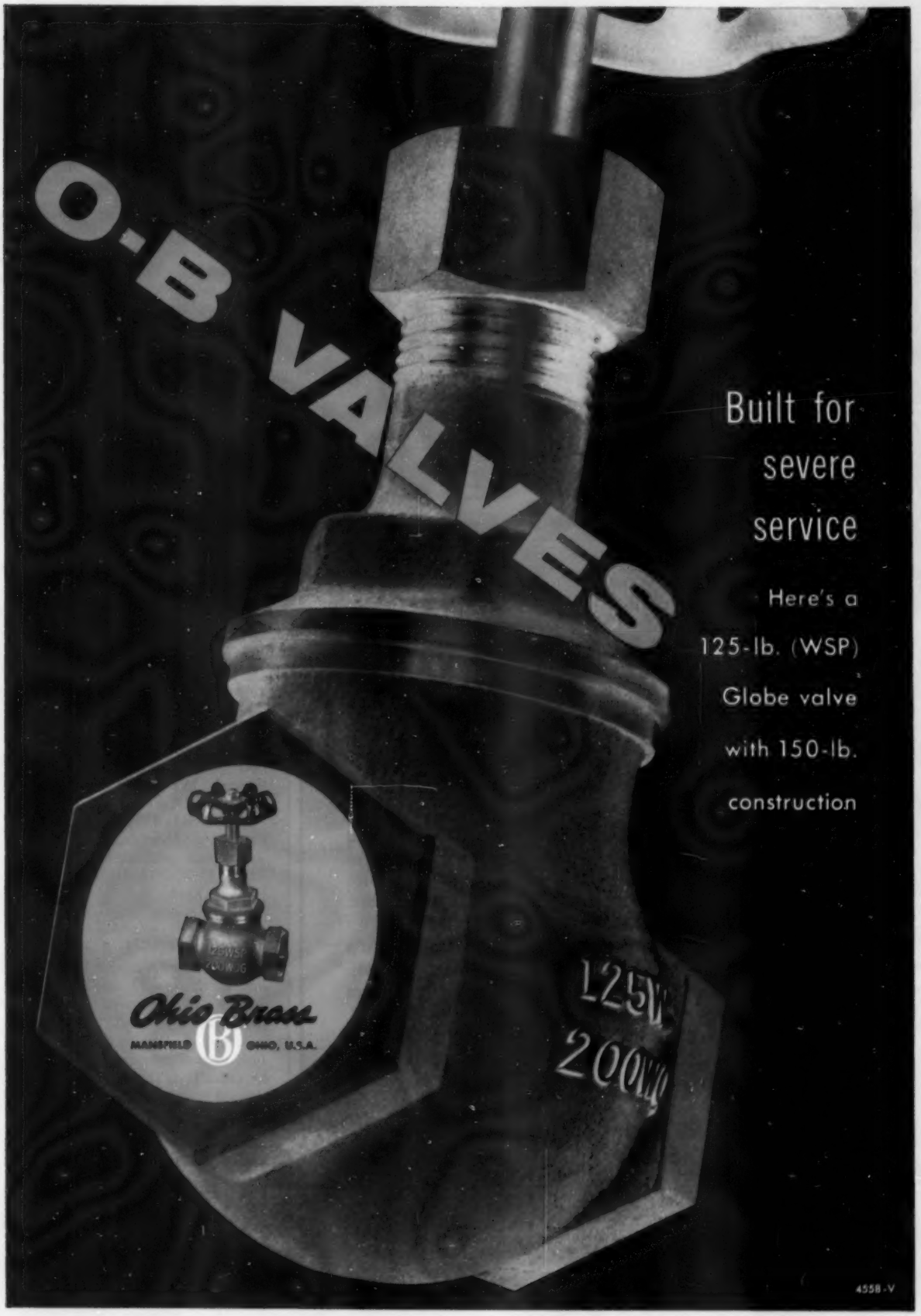
Below: Six of the fourteen Frick "ECLIPSE" compressors installed in Sperry Engineering Test Department.

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Style 177AI is dry graphite lubricated to reduce friction to a minimum. Each strand of the closely braided asbestos yarn top jacket is reinforced with Inconel wire. Core consists of long fibre asbestos and flake graphite.

Available in Spools or in Die-Formed Rings. Rings available with either square cross section or with special bevels for concave-convex nest sets.

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More TECHNICAL BRIEFS

Begins on page 160

improved methods and equipment for extracting more energy from fuel. Water specialists likewise worked endlessly to create and perfect more economical treatment methods, designed to increase on-the-line time of steam-generating and water-related equipment.

Since their goals are inexorably linked it follows that the boiler maker and water consultant should work together, not only in pursuing solutions to problems with existing equipment but, and perhaps more important, in providing boilers and water treatment of compatible design for new installations. The trend toward such cooperative effort steadily becomes more apparent, but there is still much room for improvement.

Considering the vast changes in boiler design and water treatment during the past generation—changes that are still vigorously under way—engineers would do well never to forget that boilers and boiler waters should be designed to suit each other. *APC paper; no number.*

TO OBTAIN COMPLETE TEXT

Material for these abstracts comes from the following sources unless otherwise stated. Order complete paper from sources, not POWER.

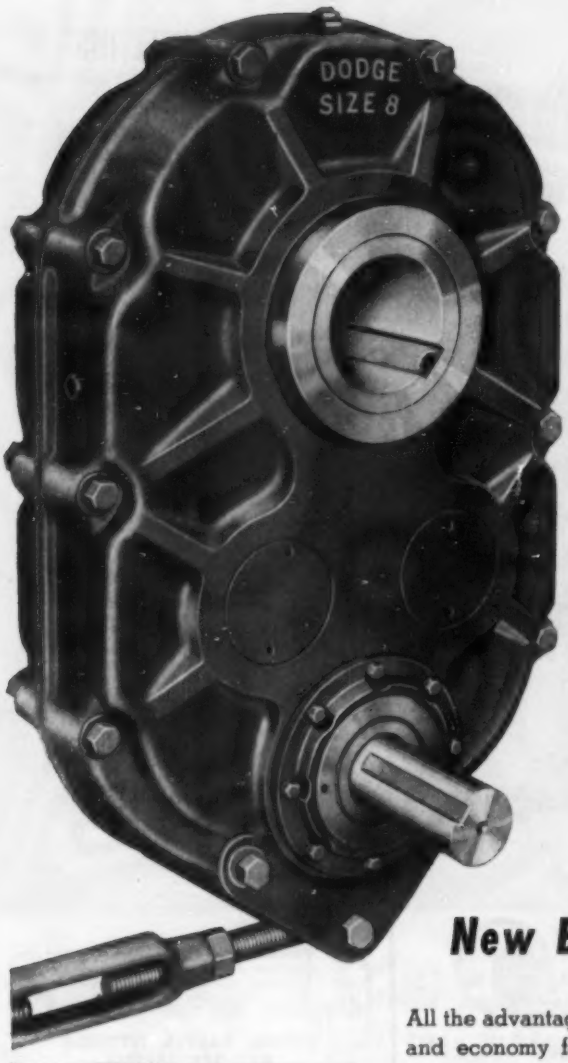
American Society of Mechanical Engineers. Identified by initials ASME and obtainable through ASME, 29 W 39th St, New York 18, New York.

American Institute of Electrical Engineers. Identified by initials AIEE and obtainable through AIEE, 33 W 39th St, New York 18, New York.

World Power Conference, 4th meeting. Identified by initials WPC and obtainable from Secretary, Brazilian National Committee, WPC, Rua Visconde de Inhauma, 134-15 Pav, Rio de Janeiro, Brazil.

American Power Conference. 16th annual meeting. Identified by initials APC and obtainable through purchase from R A Budenholzer, chairman, Illinois Institute of Technology.

A wind tunnel designed for heat transfer studies just below the speed of sound will be constructed at Illinois Institute of Technology, under an Air Force research contract. Purpose of the studies will be to gather information to be used in such problems as de-icing and anti-icing at high subsonic speed levels.



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New Big Size! New Big Savings!

All the advantages of shaft-mounting . . . all the proven performance and economy features of Dodge Torque-Arm Speed Reducers . . . are now available for your *big* jobs. The husky new size No. 8, in the double reduction series, has a capacity of 60 hp at 100 rpm, AGMA rating, and can be mounted on shafts up to 5-inch diameter.

The new No. 8 has all the inherent advantages of the Dodge Torque-Arm line. No foundation, no flexible couplings, no sliding base required—and there are no lining up difficulties. It is mounted directly on the shaft. The torque-arm, fastened to any fixed object, anchors the reducer. The unit is driven through any V-belt drive. Stock Taper-Lock Sheaves permit any speed ratio desired.

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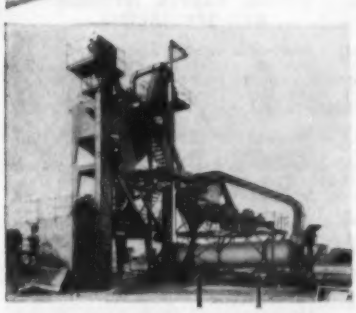

Torque-Arm Speed Reducers driving the trunnions rotating an asphalt kiln.

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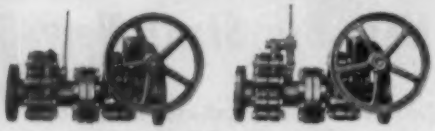
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More FREE BULLETINS

Begins on page 173

16 **Overhead cranes.** Selection data, capacities, dimensions and specs in 8-page technical bulletin 79. Whiting Corporation, Harvey, Illinois.

17 **Electric hoists.** Wire rope units in capacities from ¼ to 15 tons. Photos, charts, diagrams in 16-page bulletin P-495-A. Yale & Towne Manufacturing Co, 11000 Roosevelt Blvd, Philadelphia 15, Pa.

METALS AND ALLOYS

18 **Porous stainless steel** and other metals with controlled porosity presented in 45-page booklet. Illustrations, diagrams, charts. Micro Metallic Corp, 30 Sea Cliff Ave, Glen Cove, N. Y.

19 **Clad steels.** Illustrated 6-page bulletin discusses 16 standard alloy claddings on a variety of backing steels. Gives dollars-and-cents facts concerning economies possible. Lukens Steel Co, Coatesville, Pa.

20 **Hard-facing alloys.** Temperature curves, property descriptions, tables of three nickel-base chrome-nickel-boron alloys described in data sheet 1A. Wall Colmonoy Corp, 19345 John R St, Detroit 3, Michigan.

METERS AND INSTRUMENTS

21 **Industrial liquid meters.** Full details of several meters for batching, blending, inventory control, etc described in 8-page bulletin 567. Photos, tables, charts. Neptune Meter Co, 19 W 50th St, New York 20, N. Y.

22 **Graphic instruments.** Illustrated bulletin describes electrodynamometer measuring elements, permanent-magnet moving-coil recorders, and other recorders. Sixteen-page bulletin 854. The Esterline-Angus Co, Inc, PO Box 596, Indianapolis 6, Indiana.

23 **Recorder,** shows wind direction, speed and gustiness, to aid in solution of air pollution problems. Illustrated 4-page bulletin. Friez Instrument Div, Bendix Aviation Corp, Baltimore 4, Md.

24 **Photoelectric instruments** for detection and control of smoke and haze. Photos, diagrams in 8-page bulletin 532. Ess Instrument Co, 96 S Washington Ave, Bergenfield, N. J.

PIPING, VALVES, FITTINGS AND SPECIALTIES

25 **Stainless tubing** and pipe for corrosion control. Photos, tables, charts, reports in 28-page bulletin. Alloy Tube Div, The Carpenter Steel Co, Union, N. J.

26 **Mechanical tubing,** stainless. Photos, selection guide, properties and processing data in 6-page bulletin TB 365. Tubular Products Div, The Babcock & Wilcox Co, Beaver Falls, Pa.

27 **Flexible rubber pipe.** Applications, features, photos in 8-page bulletin H-1. Hewitt Rubber Div, Hewitt-Robins Inc, Buffalo 5, New York.

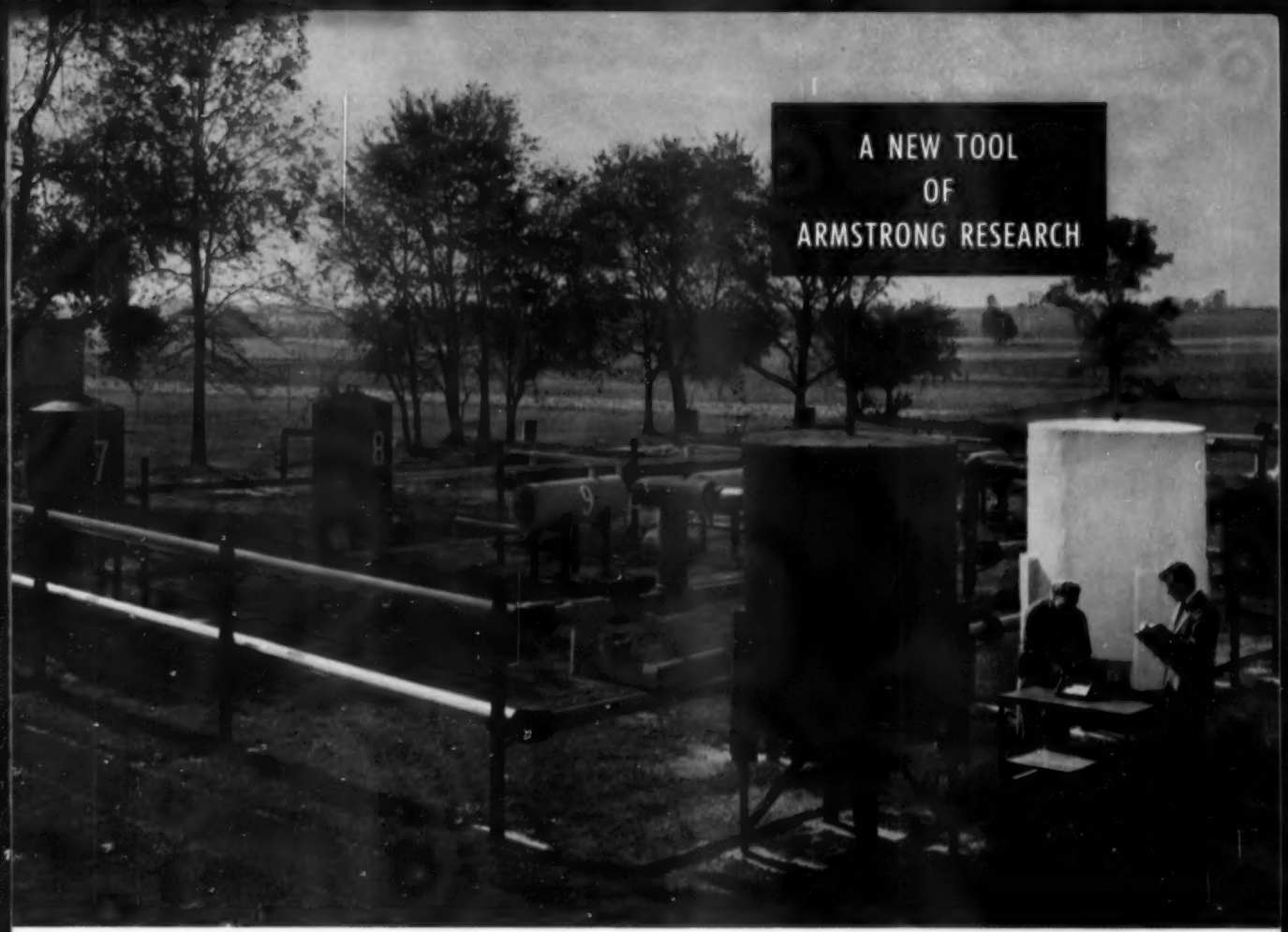
28 **Pressure reducing valves.** Self-contained and remote control diaphragm type units described in illustrated 8-page bulletin F 135. Watts Regulator Co, Lawrence, Mass.

29 **Alloy steel valves,** designed for mudline service and abrasive fluid applications. Details of 2, 3, 4-in. valves, rated at 2000 and 3000 psi WP, in 6-page bulletin 12-S. Edward Valves, Inc, 1201 W 145th St, E Chicago, Ind.

30 **Control valves,** regulators, controllers described in illustrated 4-page bulletin. Kieley & Mueller, Inc, Middletown, N. Y.

31 **Butterfly valves,** tight-closing, rubber seat, for line sizes from 4 to 36 in. Maximum velocity of 8 or 16 fps and for maximum shutoff pressure of 25 or 50 psi. Four-page bulletin 650-LI. Builders-Providence, Inc, 245 Harris Ave, Providence, R. I.

(*Continued on page 232*)



Tank Farm . . . *ideas grow into insulation specifications at this unique testing unit*

To study scientifically the effects of weather on insulations and protective finishes, Armstrong recently built a unique outdoor Tank Farm. Here, new and old insulation specifications and materials are evaluated under field operating conditions. Both high and low temperatures are held in a variety of pressurized, commercial and domestic oil tanks, and in a wide assortment of pipe lines.

The Tank Farm's equipment is extremely flexible so that insulation can be applied by one method and, if desired, replaced at any time to meet a completely different specification. Tests indicate which materials and methods warrant further development to replace current specifications.

This Tank Farm is but one example of how Armstrong Research is constantly working to improve industrial insulation materials and to develop simpler, more economical specifications. For full details on the Armstrong Line of industrial insulations and complete Contract Service, call your nearest Armstrong office or write Armstrong Cork Company, 206 Stratton St., Lancaster, Pennsylvania.

Study of new insulations, finishes, and methods of applying them is a continuous program of Armstrong Research. A new specification for applying corkboard is being made ready for testing on this experimental low-temperature tank.

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greater valve stem capacity

gives more torque

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Two piece stem nut design permits changing unit from one valve to another. Torque control for both directions of stem travel or single direction as required. Easier handwheel operation. Improved switch design and electrical arrangement. Either torque or geared limit control operation. Easier declutching.

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Do you have need for a small, low cost automatic valve operator that will give you rapid operation control of your valves? If so, the SMA-00 and SMA-000 is the answer. They are readily adaptable to all types of valves, including gate, plug, globe and butterfly.

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Condenser Tubes For Good Corrosion Resistance

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Resists impingement corrosion at higher velocities.

Unaffected by chlorination sufficient to combat biofouling.

Highly resistant to steam and steam condensate.

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Excellent corrosive resistance to a wide variety of fresh waters.

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Gives long life under conditions too severe for ordinary condenser tube alloys.

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Begins on page 173

32 **Polyvinyl chloride valves** and fittings. Molded units for 125 psi and 140 F. Four-page bulletin 601. The Lunkenheimer Co, Box 360, Cincinnati 14, Ohio.

33 **Non-return valves,** globe and angle stop valves, pressure seal design, angle univalves and small globe valves designed for chain operation in vertical lines. Illustrations, dimensions in 28-page bulletin 105. Edward Valves, Inc, 1201 W 145th St, E Chicago, Ind.

34 **Flexible shafting** for remote control of valves and equipment actuated by rotating shafts. Selection, installation, component data in illustrated 16-page bulletin 528. Stow Manufacturing Co, Binghamton, N. Y.

35 **Forged steel unions,** screw-end and socket-welding types. Dimensions, photos, specs in 4-page bulletin U-1. Watson-Stillman Fittings Div, H K Porter Co, Inc, Roselle, New Jersey.

PUMPS

36 **Sealless centrifugal** pumps. Design and development described in 12-page bulletin. Chempump Corp, Station B, 1200 E Mermaid Lane, Philadelphia 18, Pa.

37 **Vacuum pumps.** Single stage steam jet units with range from maximum air load capacities of 1.7 to 8650 lbs per hr. Photos, specs in 8-page bulletin 5-E. Schutte and Koerting Co, Dept J-P, Cornwells Heights, Bucks County, Pa.

38 **Vertical multi-stage** pumps for pressures to 1500 psi with capacities to 3500 gpm. Photos, dimensions, construction features in 12-page bulletin 7096. Ingersoll-Rand Co, 11 Broadway, New York 4, N. Y.

WATER TREATMENT

39 **Screening equipment** for water, sewage and industrial waste. Photos, dimensions and specs for various types of coarse and fine screens. Bulletin 2587. Link-Belt Co, Dept 156, 307 N Michigan Ave, Chicago 1, Ill.

40 **Clean water** and how to get it. Two-color 34-page bulletin GEA-6096 contains facts on water pollution, successful municipal campaigns, etc. Fully illustrated. General Electric Co, Schenectady 5, New York.

41 **Technical reprint** T-124, Removing oil from water by flocculation and filtration, and technical reprint T-123, applications of ion exchange to plating plant problems. Specify report desired. Graver Water Conditioning Co, 216 W 14th St, New York 11, New York.

42 **Reboiling generator** with direct contact internal vent condenser. Cutaway, operational data in 4-page bulletin 3677. The Permutit Co, 330 W 42nd St, New York 36, New York.

43 **Chemical control** and testing, to assure success of a water conditioning program, described in 6-page pocket-size folder. Hall Laboratories, Inc, Hagan Bldg, 223 4th Ave, Pittsburgh 30, Pa.

WELDING

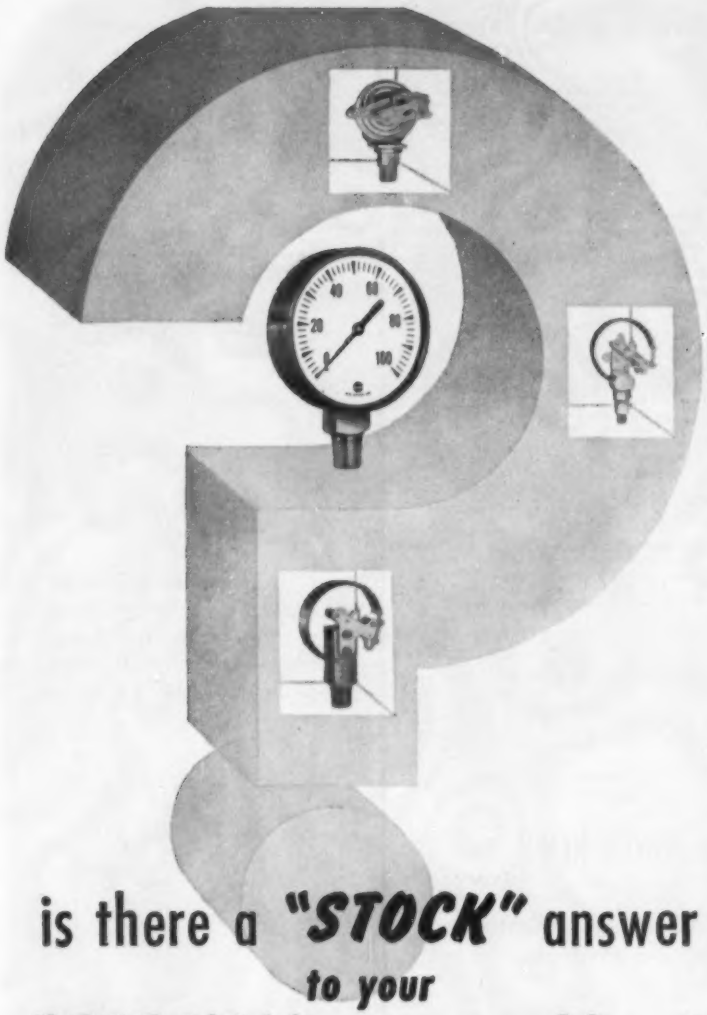
44 **"Preheating for Welding,"** an article reprint reviewing welding procedures found to produce crack-free joints under varying conditions. Tempil Corp, 132 W 22nd St, New York 11, New York.

45 **Welding** stainless tubular products. Four-page folder TDC 162 describes methods, characteristics. The Babcock & Wilcox Co, Tubular Products div, Beaver Falls, Pa.

46 **Technical reprints** — "Practical design for welding" and "Effect of welding variables on Hardfacing Deposits." Specify reprint desired. The Lincoln Electric Co, Cleveland 17, Ohio.

47 **Welding process** especially suitable for butt welding of stainless and alloy steel pipe, described in 10-page bulletin. Applications, compositions, dimensions and specs. Arcos Corp, 1500 S 50th St, Philadelphia 43, Pa.

(Continued on page 234)



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Begins on page 173

48 **Complete set** of literature describing company's line of electrodes for all welding applications. Metal & Thermit Corp, 100 E 42nd St, New York 17, N. Y.

MISCELLANEOUS

49 **"New approach** to design of hot water supply systems," discusses problems of steam surges, steam demand, temperature controls, safety devices and scale formations. Illustrated 30-page pocket-size booklet. Aerco Corp, Northvale, N. J.

50 **Jet syphons,** steam and air. Illustrated 24-page bulletin 2A includes 17 tables on suction capacities, steam consumption, operation pressures, sizes and dimensions. Schutte and Koerting Co, Dept J-O, Cornwell Heights, Bucks County, Pa.

51 **Compressors,** gas-engine driven, in 2000, 2350 and 2300 bhp sizes. Photos, cutaway, construction features, specs in 32-page bulletin 134. Clark Bros Co, Div of Dresser Operations, Inc, Olean, N. Y.

★ **Abrasive wheels.** Pocket booklet explains why abrasive wheels sometimes fail and how to prevent this failure. Also how abrasive wheels cut. Illustrated, 40-page booklet. ★Request direct on company letterhead from Wallace Tube Co, 1300 Diversey Pkwy, Chicago 14, Illinois.

52 **Manufacturing service.** Illustrated 8-page bulletin outlines services in design and construction of process plants and units, design and fabrication of special processing equipment, joints for pipe line movements, vapor compression stills. Badger Manufacturing Co, 230 Bent St, Cambridge, Mass.

More POWER NEWS

Begins on page 158

1951 World Power Conference transactions available

► TRANSACTIONS COVERING reports and discussions of the sectional meeting, World Power Conference, held in New Delhi, India in 1951, in connection with the International Engineering Conference, are now available.

Six technical sessions were held for discussion of "Utilization of Power in its Various Aspects," under twelve subheadings of two main subjects. Main subjects were utilization of electricity in agriculture and coordination of the development of industries and development of power resources.

Nineteen reports were presented on the first subject by representatives of eleven nations. Under the second main subject 28 reports were presented by representatives of nine countries. Various phases included power load planning, modern equipment methods, and research in power utilization; power and cottage industries; interconnection and coordination of power systems; design and construction of power stations and transmission facilities.

Reports from the U.S. were by D L Beeman on "Power Distribution in

(*Continued on page* 238)

This case came to a head in a New York cosmetic plant. Keeping dry powder moving through the bins and drums without costly jam-ups was a real problem.

We're happy to say a CLEVELAND vibrator on each bin and drum was the ideal solution. In no time at all production delays became a thing of the past.

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When a chemist or engineer wants to soften water, dealkalize it, eliminate dissolved salts (including silica) and, in general, remove or replace salts in solution, where should he turn for help?

The illustration above—just a portion of a collection of AMBERLITE® ion exchange resin samples—is a clue to the answer. The full answer is found in the knowledge and experience of water conditioning experts who consult this "library" and avail themselves of Rohm & Haas Company's ion exchange research and production facilities.

Many of the AMBERLITE ion exchange resins shown here are up-to-date, widely recommended and used. Others, such as the first commercially produced exchanger, are already antiquated by new Rohm & Haas developments. Some are experimental: they await only a need—perhaps yours.

If your problem involves the ion exchange treatment of water, why not ask your water conditioning firm about AMBERLITE ion exchange resins? Meanwhile, ask to be put on the mailing list for AMBER-HI-LITES, a bi-monthly report on ion exchange developments.

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WHEN A 16-cylinder, 1,750-hp diesel engine roars into action, the air-cooling and circulation piping really has to "take it." This particular installation performs perfectly because it is equipped with Penflex Flexible Metallic Tubing. A 5-foot length of air-jacketed 14" interlocked Penflex Tubing reaches from exhaust to stack. Its tough, rugged, "seep-proof" construction holds exhausts tight as a pipe . . . yet it is flexible enough to absorb the constant vibration.

In the power field you have many calls for Penflex—for air and gas lines, for transmission of oil, steam, and liquids. There is a complete line of steel, bronze, and aluminum Penflex Flexible Tubing, Hose and Couplings in sizes from 1/8" to 24" I.D.

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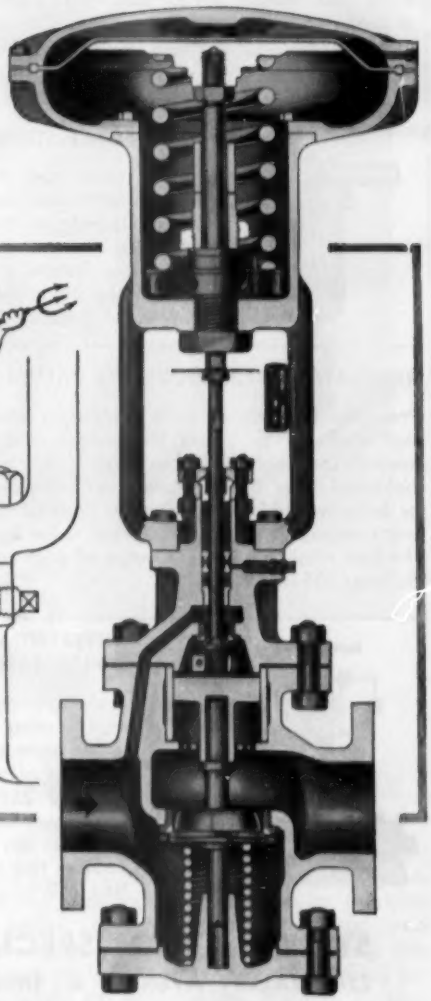
PENFLEX

HEART OF INDUSTRY'S LIFE LINES

PACKING PROBLEMS?

The new Leslie Lubrisoft® Packing now standard in all Leslie Diaphragm Control Valves is recommended for valve body temperatures up to 500° F. *without external lubrication.* When used with the Leslie thermo-isolating bonnet, it may be used for valve body temperatures up to 1050° F., eliminating need for external lubricators and isolating valves in most applications.



LESLIE LUBRISOFT® PACKING "BEATS THE DEVIL" OUT OF ALL 8 MOVING STEM SEAL PROBLEMS

Each of the several types of Lubrisoft split ring packing is specifically designed to maintain the low-friction stem seal against one or more of these deteriorative service conditions:

1. **Internal pressure, temperature and fluid**
2. **Contamination**
3. **Corrosion**
4. **Electrolytic Action**
5. **Oxidation**
6. **Extrusion**
7. **Abrasion**
8. **Friction**

Overall result is a standard, economical packing, with superior stem sealing properties and long service life. Precision fabricated to conform exactly to the deep stuffing box dimensions, the positive, split ring design makes fast replacement possible, without disturbing body or stem adjustment.

Plan to reduce control valve maintenance costs by sending for Bulletin 5304 Diaphragm Control Valves.

LESLIE CO., 235 GRANT AVENUE • LYNDHURST, NEW JERSEY

TRADE LESLIE MARK **CONTROL VALVES**

"STILL FAR AHEAD IN QUALITY AND PERFORMANCE"

Stickle equipment is guaranteed to

Cut Steam Costs

OPEN COIL FEED WATER HEATERS

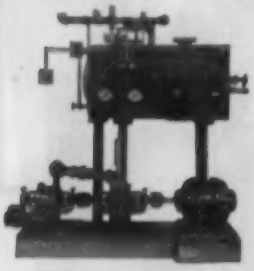
Guaranteed to heat water to a higher temperature in less space than any other heater; to deliver feed water to pump at same temperature as saturated steam in the heater. Deaerating and non-deaerating types. Deaerating type reduces oxygen content to .005 cc per liter of water. Steel or cast iron shells. Capacities: 3,000 to 300,000 pounds per hour. Bulletin 117.

OPEN FLOAT STEAM TRAPS

Provide quick sure drainage of heating and processing units. Instantaneous discharge of air and non-condensable gases. Operate on time-tested open float principle. Self-regrinding valve and seat. No levers, hinges or pins to replace; no thermal elements or diaphragms to rupture or crack. Many still in use after 40 years. Sizes and styles for every need. Bulletins 115, 315, and 415.

REGULATING AND REDUCING VALVES

Provide automatic pressure regulation and reduction for liquid, air, steam. Used where most exacting control is essential. Self-contained. Single seated, balanced . . . or double seated, semi-balanced. Spring or lever weight-loaded. Lever or float operated. All parts accessible without removing valve body from the line. Available in wide range of sizes and styles. Bulletins 235 and 435.



DIFFERENTIAL DRAINAGE AND BOILER RETURN SYSTEM

A closed pumping system for returning condensate from heating and processing units to boilers at a temperature only 15 to 20 degrees lower than temperature of steam at operating pressure. Saves 10% to 25% of boiler fuel. Increases boiler capacity. Maintains higher, more uniform pressure. Delivers drier steam at higher temperature. Reduces raw make-up water and scale 85%. Bulletin 250.

STICKLE STEAM SPECIALTIES COMPANY

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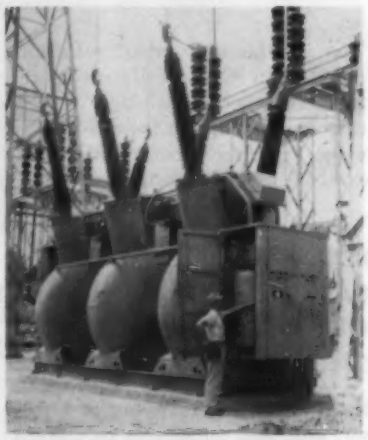
Stickle has engineered and built *guaranteed* steam specialties since 1905

More POWER NEWS

Begins on page 158

Light and Heavy Industries," F R Benedict on "Electric Power and Heavy Industries," M W Straus on "Water and Power in Our World," A C Clogher and R P Crippen on "Coordinated Utilization of Thermal and Hydro Energy Resources."

Volumes I, II and III may be obtained through purchase from the Secretary of the Indian National Committee, World Power Conference, 8 Gokhale Road, Calcutta 20, India. When ready, Volume IV, the index, will be sent to purchasers of complete sets.



First 230 kv circuit breakers installed in Southeast

► Two 230-kv, 1200-amp circuit breakers with interrupting capacity of 5,000,000 kva were recently installed at Riverbend Steam Plant of Duke Power Co.

Located near Charlotte, N. C., they are the first units of this high voltage to be installed in the Southeast. They will help protect the first "super-voltage" transmission lines in this section of the U.S. The equipment was manufactured by General Electric Co's high voltage switchgear dept at Philadelphia.

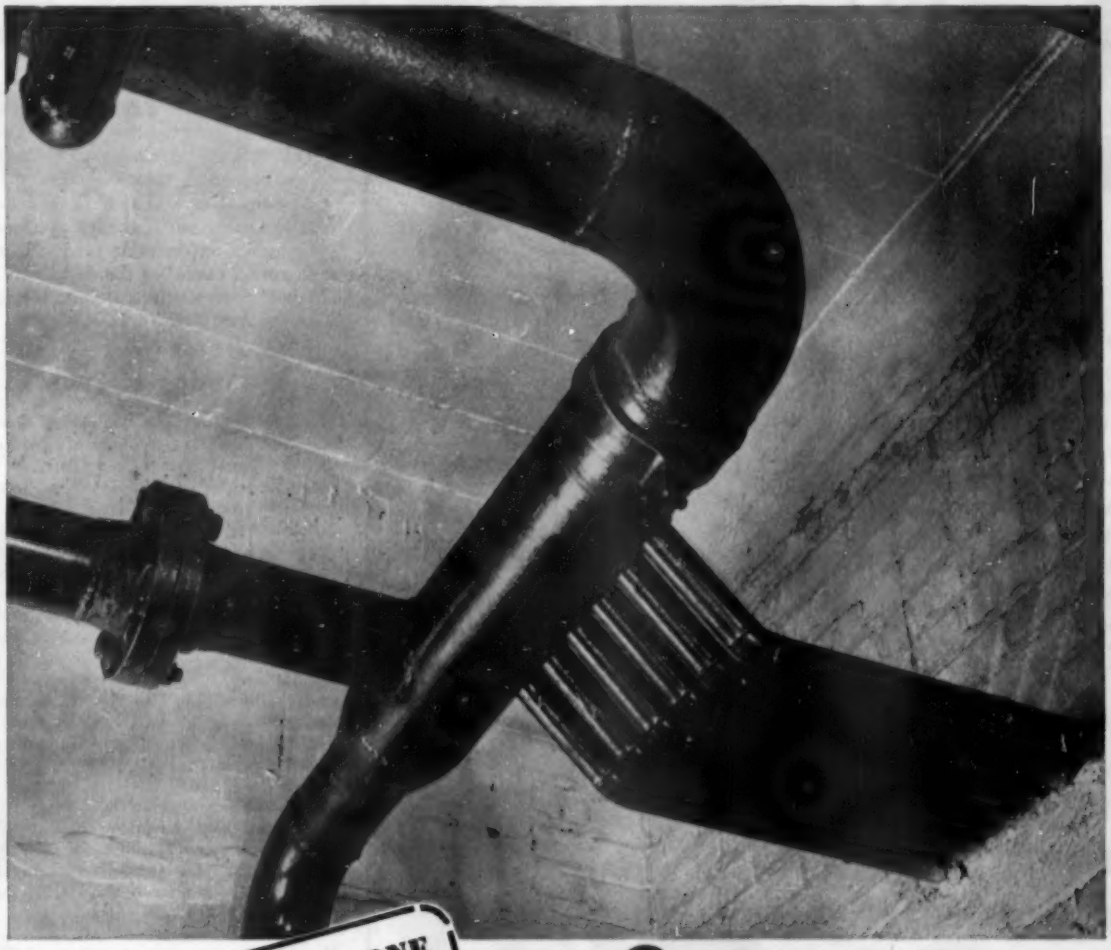
Whenever lightning strikes or other faults occur, the breakers are capable of interrupting the flow of electricity in one-twentieth of a second. Flow may be restored so fast that only indication is a momentary flicker of electric lights.

Basic Materials Exposition to include design engineering

► The third Basic Materials Exposition, to be held at Convention Hall, Philadelphia, May 31 to June 3, will be broadened to include the subtitle, "The Design Engineering Show."

The Basic Materials Exposition, held in Chicago last year, is unique among industrial shows because no machinery nor end product was displayed. Exhibits

How to Tame a Tough Joint



ANOTHER JOB DONE BETTER WITH GLOBE WELDING FITTINGS

KEEP an eye on the future when you install piping—even the most innocent looking connection can become a "tough joint" through leakage — pressure-loss — the focal point for erosion and corrosion — constant maintenance time and cost.

You can tame probable "tough joints" in piping by making connections with permanently tight, leakproof Globe Welding Fittings. Strength is forged in the fittings — flow friction and pressure-loss minimized by precision formed true angles, radii, circularity—weight and space requirements reduced—exact dimensional accuracy that saves time, speeds piping assembly. To do any piping job better — use Globe Precision-Process Welding Fittings.

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TUBULAR PRODUCTS DIVISION
Fittings Department
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A World of Facts On

SUPERIOR COAGULATION!

Free Booklet—

We want you to have a copy of this completely revised, up to the minute booklet that contains a world of information that will greatly assist you in problems you may have in **WATER TREATMENT, SEWAGE TREATMENT, INDUSTRIAL WASTE TREATMENT, SLUDGE CONDITIONING,** and other uses of Ferric-Floc.

Drop us a card for your copy of this booklet that contains valuable information for you.

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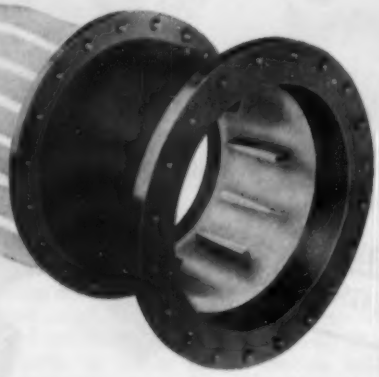
FOR *LOWEST* HEAD LOSS IN FLUID METERING



The *Gentile** **FLOW TUBE**

*GEN-TILE-LY

WHERE HEAD LOSS IS IMPORTANT...The Gentile Flow Tube can be designed to produce a measurable differential with lowest permanent pressure loss of any head meter.

ACCURACY... Differential is produced from points of equal cross-sectional area. Furnished with head capacity curves, and guaranteed for exceptional accuracy when used with any standard indicating, recording or integrating meter.

REVERSIBILITY...When the flow is reversed, the differential is reversed. Permits metering reverse flow at lowest possible equipment cost.

LOW INSTALLED COST...Average length is only 1½ times the pipe diameter, and straight runs entering and following are not required unless installed near throttling valves or regulators.

Write for Bulletin FT-101 or specific recommendations.

FOSTER ENGINEERING COMPANY

835 LEHIGH AVENUE UNION, N. J.

AUTOMATIC VALVES • SAFETY VALVES • FLOW TUBES

More POWER NEWS

Begins on page 158

were restricted to materials that go into making end products for consumer or industrial use.

With the broadened scope this year, however, certain manufactured products that are themselves included in the manufacture of end products will be shown. These include mechanical, electrical, hydraulic and pneumatic components of end products, as well as finishings, coatings and other parts, shapes and forms.

Complete information and advance registration cards for the event may be obtained from Clapp & Poliak, Inc, 341 Madison Ave, New York 17, N. Y.

Calendar of Events

Feb 23—Instrument Society of America, annual winter conference of New York section. Hotel Statler, New York, N. Y. Direct inquiries to Mr Hamilton Bristol, general chairman, c/o Bristol Co, 250 W 57th St, New York, New York.

Mar 1-2—First International Congress on Air Pollution, Hotel Statler, New York, N. Y. Complete information from ASME, 29 W 39th St, New York 18, New York.

Mar 7-11—National Association of Corrosion Engineers, 11th annual conference and exhibition. Palmer House, Chicago, Ill. Details from NACE, 1061 M & M Building, Houston 2, Texas.

Mar 14-18—American Society of Tool Engineers, 23rd annual meeting and first western industrial exposition. Shrine Auditorium and Exposition Hall, Los Angeles, Calif. Details from Denham & Co, 925 Book Building, Detroit 26, Michigan.

Mar 15-17—American Institute of Electrical Engineers, utilization of aluminum conference. William Penn Hotel, Pittsburgh, Pa. Details from AIEE, 33 W 39th St, New York 18, New York.

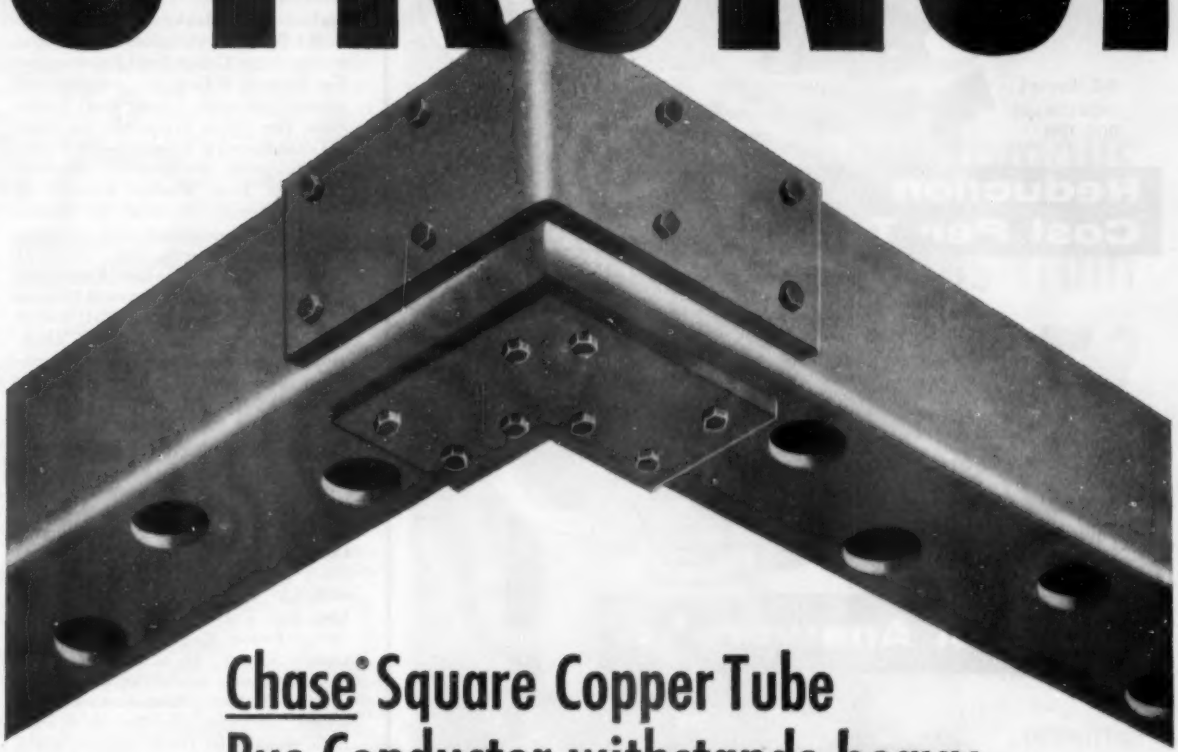
Mar 28-29—American Institute of Electrical Engineers, materials handling conference. Hotel Cleveland, Cleveland, Ohio. Details from AIEE, 33 W 39th St, New York 18, New York.

Apr 18-19—Third National Air Pollution Symposium, Huntington - Sheraton Hotel, Pasadena, Calif. Details from Stanford Research Institute, Stanford, Calif.

Apr 27-29—Society for Experimental Stress Analysis, spring meeting. Hotel Statler, Los Angeles, Calif. Further information from Dr W M Murray, SESA, Box 168, Central Square Station, Cambridge 39, Massachusetts.

A second 50,000-kw generating set will be set up by 1956 on Trombay Island, India, as a result of an agreement between the Government of Bombay and Tata Hydroelectric Company.

STRONG!



Chase® Square Copper Tube Bus Conductor withstands heavy short circuit stresses, minimizes sag!

The square cross section configuration of Chase Ventilated Square Copper Tube Bus Conductor gives it the extra strength needed to withstand the stress of heavy short circuits . . . to permit longer spans between supports!

The heat-dissipating vent holes in Chase Bus Conductor that increase current-carrying capacity up to 20% *also* save you as much as *36%* in weight of copper in comparison with flat rectangular bus bar!

For full information about Chase Ventilated Square Copper Tube Bus Conductor, send for the free Chase Bus Conductor Brochure.

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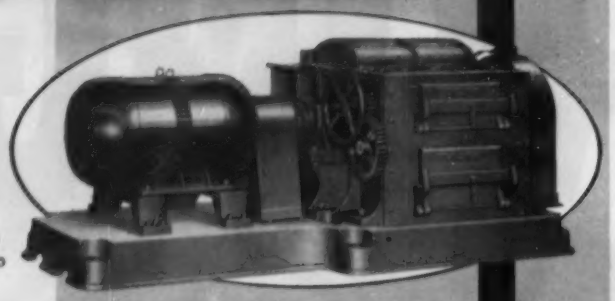
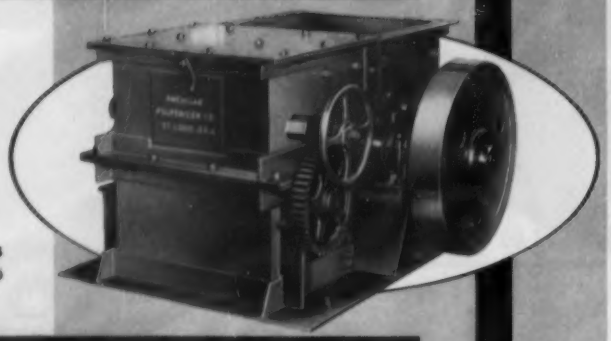
Charlotte†	Denver	Kansas City, Mo.	New Orleans	Rochester†	(†sales office only)

When You Figure . . .



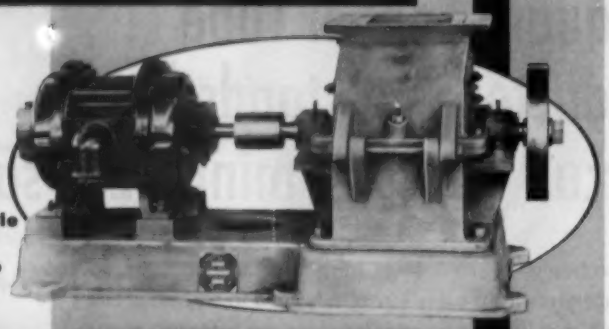
AC Series
capacities to
800 TPH

Reduction
Cost Per Ton . . .



WC Series
capacities to
90 TPH

the Best Answers*. . .



Coal Sample
Crushers
capacities to
2000 Lbs.
Per Hr.

Come from American
Ring Coal Crushers

*In a recent independent survey, it was found that American Crushers reduced over 61,000,000 tons of coal at a parts replacement cost (including standby parts) of less than 1/10th of 1¢ per ton.

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APPOINTMENTS

Corporation executive changes

National Gypsum Co: Fred A Manske, executive vice-president; Wells F Anderson and William M North, vice-presidents. **The Chapman Valve Manufacturing Co:** Ernest Cochran, president and general manager. **Westinghouse Air Brake Co,** Le Roi div: Paul I Birchard, vice-president and general manager. **Green Fuel Economizer Co:** Kenneth B Gair, vice-president and general manager. **American Brake Shoe Co:** Cyrus Brush, vice-president.

Texas Eastern Transmission Corp: J W Hargrove, vice-president. **Bonney Forge & Tool Works:** Kenneth W Foust, director; Spencer H Mieras, executive vice-president and director. **Microwave Services, Inc:** Victor J Nexon, president. **United Engineers & Constructors Inc:** Henry M Chance, II, president. **Rawson & Co:** Robert E Houlihan, vice-president. **U.S. Hoffman Machinery Corp:** Revis L Stephenson, vice-president in charge of new industrial equipment div.

Operations executive changes

General Electric Co: Joseph W Seaman, general manager of power transformer dept. **Philadelphia Electric Co:** J A English, manager of emergency procedures div. **National Gypsum Co:** Lewis B Crowell, George E Koch and W J Sprau, production managers. **Dravo Corp,** machinery div: Gustav Schwab, Jr, manager of Marietta, Ohio pipe fabrication plant.

Allis-Chalmers Manufacturing Co, general machinery div: Norman L Danforth, manager of Toledo district. **Michigan Tool Co:** A D Moncrieff, manager of machine tool and cutting tool divisions. **Eutectic Welding Alloys Corp:** Joseph F Quass, director of manufacturing and production. **Formsprag Co:** Leo B Zaremba, production manager; William N Lesnew, shop superintendent. **Graybar Electric Co:** J E Carroll, manager, Pittsburgh district. **The Kuljian Corp:** Daniel H Dykins, manager of utilities.

Federal Pacific Electric Co: E A Williams, manager of eastern switchgear div. **Thomas & Betts Co:** John C Kaufmann, product manager. **Borg-Warner Corp:** Louis Paul Smith, vice-president of manufacturing for Morse Chain Co. **General Metals Corp:** John H Sheusner, manager of operations of Enterprise div. **Cleaver-Brooks Co:** Paul Honnold, export manager. **The Ohio Injector Co:** Verland W Belt, general superintendent.

Engineer changes

Babcock & Wilcox Co, boiler div: George W Kessler, chief engineer. **Michigan Tool Co:** Clayton E Scott, chief engineer. **Metropolitan Refining Co, Inc:** Frederick S Hodgdon,

ARE YOU (OR YOUR STAFF MEMBERS) READING AND USING these famous special sections from *Power*?

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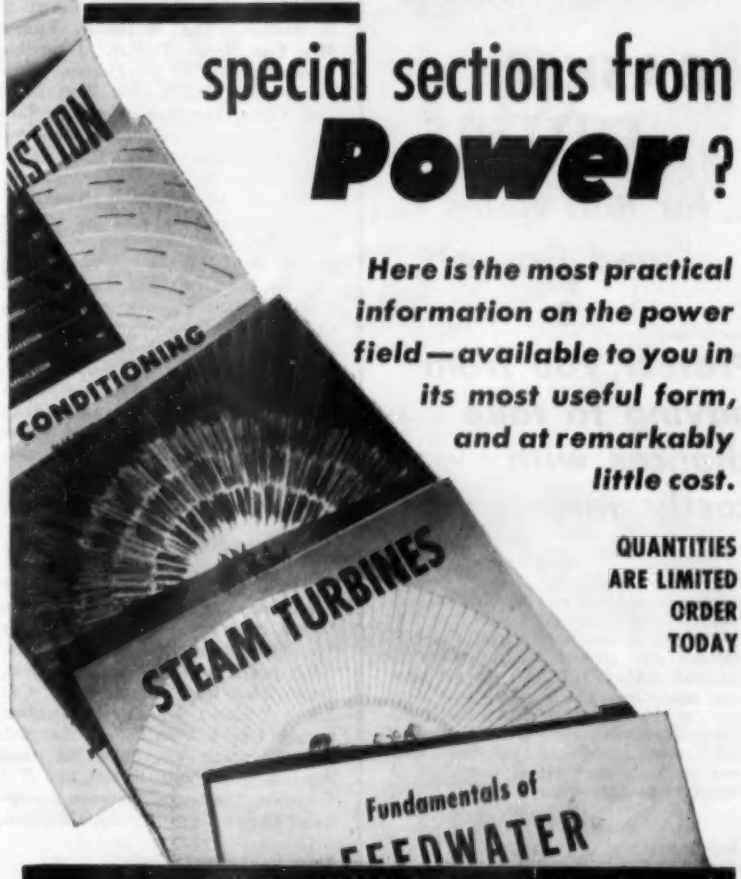

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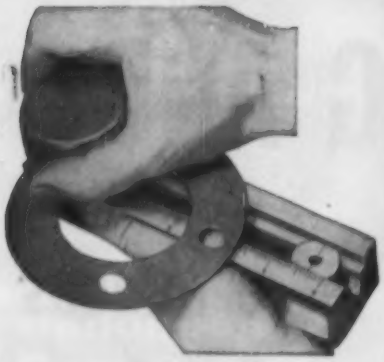

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... for Bolt Holes and Gaskets ...

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With this tool you are prepared for any emergency where gaskets are involved. You don't have to have a big stock of miscellaneous size gaskets because with the ALLPAX GASKET CUTTER you cut what you require immediately as you need them . . . in the size and of the material the job calls for. In other words your gaskets are "custom made" . . . cut faster than you could get them out of your stock of maintenance materials.

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More APPOINTMENTS

Begins on page 242

associate chief engineer for water treatment in air conditioning and allied equipment. **The Kuljian Corp:** William J Fadden, Jr, chief mechanical engineer. **Elwell-Parker Electric Co:** J A Ackermann, chief engineer. **The Trane Co:** Robert G Weiske, research and testing laboratories. **Continental Foundry & Machine Co,** Copes-Vulcan div: Jefferson C Falkner, engineering and customer consultant.

New sales managers

H K Porter Co, Inc, Leschen Wire Rope div: G F Ryan, New York district. **Gruybar Electric Co, Inc:** H G Cook, Detroit district; G L Call, Cincinnati district. **Tennessee Corp:** E H Shelton. **The Weinman Pump Mfg Co:** Harvey R Ray. **Johnston Pump Co:** Charles J Schleeweis. **The Trane Co:** Fred Raible, West Hartford, Conn. **Joy Manufacturing Co:** H B Zeppenfeld, electrical connector div. **J E Berger Corp:** C E Smith, sales manager and ass't to vice-president.

General Electric Co: Russell T Morris, manager of lightning arrester and cutout sales for distribution transformer dept. **All-State Welding Alloys Co, Inc:** Harry G Peacor, regional manager with headquarters in Portland, Ore. **Electric Controller & Mfg Co:** I H Peak, Philadelphia district. **Layne & Bowler Pump Co:** James W L Stone, industrial sales. **Mason-Neilan Regulator Co, Ltd of Canada:** John O Tragard. **Westinghouse Air Brake Co:** Charles J Haring, equipment sales.

New sales engineers

Allis-Chalmers Manufacturing Co: Donald B Scott, in charge of induction heating group. **Reliance Electric & Engineering Co:** Charles F Carnish, Detroit district. **The National Supply Co,** engine div: D C Vick, Lincoln, Nebr. and R A McCloskey, Springfield, Ohio. **The Rust Engineering Co:** James A Slater. **Hendrick Manufacturing Co:** E Donald Schreckengost. **The Permutit Co,** industrial sales dept: K G Barnhill, Boston, and E J Connelley, Cincinnati. **Nareseo Equipment Corp:** Harry D Stone, Cleveland.

New representatives

For **Cochrane Corp:** Turbine Equipment Co, 222 Glen St, Glen Falls, N. Y. For **Hungerford & Terry, Inc:** R D Murphy, 6801 Euclid Ave, Cleveland 3, Ohio. For **Feedrail Corp:** Eichorn & Melchior, 500 Minnesota St, San Francisco 7, Calif.

For **U.S. Hoffman Machinery Corp,** air appliance div: T R Christy Co, 3253 N Green Bay Ave, Milwaukee, Wis. For **Richardson-Allen Corp:** Andrew H Baxter, 412 Albee Bldg, Washington, D.C. For **Detrex Corp:** Platt K Wiggins, western New York State. For **Hose Accessories Co:**

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A practical view of the working and application of just those automatic controls used in the heating, ventilating, and air-conditioning field. Covers electric and pneumatic control of domestic heating unit heaters and ventilators, commercial heating, cooling, and refrigeration systems, and radiant panel heating. **By John E. Haines, Vice-Pres., Minneapolis-Honeywell Regulator Co. 354 pp., 200 illus., $6.75**

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More APPOINTMENTS

Begins on page 242

Durrie Sales Co, 605 W Washington St, Chicago 6, Ill. For **McQuay Inc:** John Mucha, Rockford, Ill.

For **Cuno Engineering Corp:** H G Klug Co, Omaha, Nebr. For **The Standard Transformer Co:** J L Howarth Co, 2550 Beverly Dr, Birmingham 9, Ala; and Charles L Ward Co, 5707 Waterbury Circle, Des Moines 12, Iowa and 502 Grove Ave, Corning, Iowa. For **T J Cope:** Bradley Co, Philadelphia, Pa. For **American Water Softener Co:** Piepenbrink Engineering Co, 53 W Jackson Blvd, Chicago 4, Ill.

New distributors

For **New York Belting & Packing Co:** Woodbury & Co, Portland, Ore. For **Chrysler Corp:** General Machinery Corp, 1227 W Marrietta St, Atlanta, Ga, full line of industrial engines. For **K S M Products, Inc:** Mobile Welding Supply Co, Inc. For **Morse Chain Co:** Southern Bearings Service Co, 491 S Second St, Memphis, Tenn, and 519 W Seventh St, Little Rock, Ark; The Kelly Supply Co, 1004 W Oklahoma Ave, Grand Island, Nebr; L B Adams & Co, 530 N 49th St, Baton Rouge, La; Fisher Bros Co, Astoria, Ore; and Neiman Bearings Co, 2837 Locust St, St Louis 3, Ill, and 812 Illinois Ave, E St Louis, Ill.

Recent moves

Kepco Laboratories: to new addition of Flushing, N. Y. plant at 131-38 Sanford Ave. **Rowland Tompkins & Son, Inc:** main office to new building at 50 Broadway, Hawthorne, N. Y. **J N Fauver Co, Inc:** stocking warehouse and branch from Dayton to 5562 Montgomery Rd, Cincinnati, Ohio. **Bailey Meter Co:** New Orleans office to larger quarters at 909 S Jefferson Davis Pkwy, New Orleans 25, La. **Aget Manufacturing Co:** sales and mfg divisions combined at executive headquarters, 1408 E Church St, Adrian, Mich.

New district offices

Cochrane Corp: at 261 Madison Ave, New York 16, N. Y., Joseph R Denton, manager. **Consolidated Engineering Corp:** at Ellis Bldg, 3053 Main St, Buffalo, N. Y., Eugene J Moscaret, manager. **Reliance Electric & Engineering Co:** at 5856 N Port Washington Road, Milwaukee, Wis., Vernon S Barnes, manager.

American Blower Corp: direct factory branch offices at 921 SW Washington St, Portland, Ore., W S Cooper, manager; and at 517 Gettle Bldg, Fort Wayne, Ind., J W Johnson, manager. **U.S. Rubber Co:** distribution center and warehouse at 24-01 Brooklyn-Queens Expressway West, Long Island City, New York.

Fluor Corp, Ltd: at Denver, Colo, L O Calkins, manager. **Robertshaw-Fulton Controls Co,** Fielden Instru-

Can your proportioning pumps match this for convenience and versatility?
Easy, precise stroke adjustment — adjustment while-in-operation a low cost extra.
All pump bodies interchangeable in the housing for easy convertibility.
Unitized construction — motor, pump and drive mounted on a common base.
Separate, interchangeable external check valves for easy dismantling or replacement.
HILLS-McCANNA "U" TYPE PROPORTIONING PUMPS

Hills-McCanna "U" Type Proportioning pumps combine precision operation with high standards of convenience and versatility not ordinarily associated with pumps of this type. The "U" pump is easy to install and can be converted quickly and economically for changing service requirements.

If you must continuously meter or proportion small volume flows with great accuracy, it will pay you to consider a Hills-McCanna "U" Type Pump. Capacities range from 0.10 to 24 gph per feed, 1, 2, 3 and 4 feed units are available.

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HILLS-McCANNA

metering and proportioning pumps

Also Manufacturers of:
SAUNDERS TYPE DIAPHRAGM VALVES
FORCE FEED LUBRICATORS • MAGNESIUM SAND ALLOY CASTINGS

FOR REPLACEMENTS ORDER HIGH PRESSURE
GAGE GLASSES
MAGNIFYING RED LINE

MASTER STANDARD RED LINE & CLEAR
Up to 500 lbs.

MASTER CLEAR & RED LINE EXTRA STRONG
Up to 600 lbs.

Made in Lengths up to 144" Long
And Outside Diameters ⅜", ½", ⅝", ¾", ⅞", 1", 1¼", 1½".

High Pressure Composition
ERNST RUBBER GASKETS
All sizes to fit your gages and valves

FIG. 21—Lip Mold

FIG. 22—Standard

ERNST WATER COLUMN & GAGE CO.
Send for Catalog LIVINGSTON, N. J.

Reach any Overhead Valve From the Floor with...
Babbitt
Adjustable
SPROCKET RIM
with Chain Guide

Get positive, efficient control of any overhead valve right from the floor! No expensive apparatus, no switches, no costly detours to bring overhead piping to floor level — because every valve is within easy reach, when you use low-cost Babbitt Adjustable Sprocket Rim with Chain Guide. Easily assembled and installed, ready to operate in a few minutes.

- Safe, sane & sensible
- Cuts piping costs
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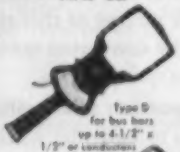
Range of 10 adjustable sizes fits all valve wheels from 2 to 30 inches diameter, with rising or non-rising stems. Only four simple, quickly-assembled parts.

Call your Industrial Distributor. He carries complete stocks. Or write for descriptive folder and prices.

Babbitt STEAM SPECIALTY CO
2 BABBITT SQUARE, NEW BEDFORD, MASS.

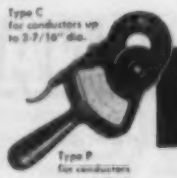
READ BOTH AC and DC WITH...
TONG TEST AMMETERS
5091-CE

Type AX
Type A
for conductors up to 1-9/16" dia.



Type D
for bus bars up to 4-1/2" x 1/2" or conductors up to 3-3/4" dia.

Type C
for conductors up to 3-7/16" dia.



Type P
for conductors up to 1/2" dia.

Only Tong Test measures both alternating and direct current. Simply snap the tongs around electrical conductor for instant readings . . . only one scale to read at a time. Ranges are quickly interchangeable.

Lightweight, accurate, safe, dependable . . . Tong Test is available in five types for use on AC frequencies up to 400 cycles as well as DC.

Write for 8-page Catalog PR-400.

Type	AC-DC Ampere Ranges, Available As Specified
AX	50, 75, 100, 150, 200, 300, 400, 500, 600, 800, 1000
A	50, 75, 100, 130, 200
D	75, 100, 130, 200, 300, 400, 500, 600, 800, 1000
C	75, 100, 130, 200, 300, 400, 500, 600, 800, 1000
P	20, 30 or 40 (Not interchangeable)

COLUMBIA
COLUMBIA ELECTRIC MFG. CO.
4511 Hamilton Avenue • Cleveland 14, Ohio

More APPOINTMENTS

Begins on page 242

ment div: at div's plant, Philadelphia, Pa. **Federal Pacific Electric Co:** at 612 Roanoke Bldg, Minneapolis, Minn, A E Johnson, manager. **Mycalex Corp of America:** at 5657 Wilshire Blvd, Los Angeles 36, Calif, Kenneth V Tindall, manager; at 6677 N Northwest Hgwy, Chicago, Ill, Leslie F Thompson, manager; and at 801 SE 8th St, Minneapolis 14, Minn, D A Schultz, mgr.

Recent purchases

Minneapolis - Honeywell Regulator Co: outstanding capital stock of Doelcam Corp. **Babcock & Wilcox Co:** assets and business of Globe Steel Tubes Co. **H K Porter Co, Inc:** acquisition of Riverside Metal Co. **The Peerless Electric Co:** physical assets of Sherman Electric Co, Inc. **Clarostat Mfg Co, Inc:** acquisition of Campbell Industries Inc. **American Locomotive Co:** acquisition of Central Pipe Fabricating & Supply Co. **Kuhlman Electric Co:** assets and machine operations of State Metal Fabricators, Inc.

Awards

Walker L Cisler: ASME George Westinghouse Gold Medal Award. **Sam Tour:** ASTM Award of Merit. **Edwin B Powell:** ASME Medal for distinguished service in engineering and science. **Joseph H Keenan:** ASME Worcester Reed Warner Medal.

William E Umstattd: ASM Medal for the Advancement of Research. **Alexander L Feild:** ASM Albert Sauveur Achievement Award. **Alfred P Sloan Jr:** Hoover Medal.

Obituaries

Lionel S Marks, 83, Gordon McKay professor emeritus of mechanical engineering at Harvard University, on Jan 6. Mr Marks was the author of "Mechanical Engineer's Handbook." He was graduated from Mason College, Birmingham, England and from the University of London. He obtained a degree in mechanical engineering from Cornell University in 1894 and joined the Harvard faculty that year.

Edward T Gushée, 59, vice-president of The Detroit Edison Company, on Dec 15th.

William C Frye, 77, director and former president of Chain Belt Company, on Nov 16th.

William W Vosper, 79, founder of The Toledo Pipe Theading Machine Company, on Dec 17th.

Duncan W Fraser, 79, retired chairman and former president of American Locomotive Company, on Dec 20th.

Members of the American Society of Heating and Ventilating Engineers have voted to change the name of the 36-yr old society to American Society of Heating and Air-Conditioning Engineers, Inc.

BOOKSHELF

Diesel and High-Compression Gas Engines—Fundamentals. *By Edgar J Kates, consulting engineer. 396 pp, 5¾x8½, illus, tables, cloth, $5.50. American Technical Society, 848 E 58th St, Chicago 37, Ill.*

This is a unique book giving the newcomer and old-timer an excellent introduction to the principles, construction and operation of diesel and high-compression gas engines. Well illustrated, the book is listed by the *Library Journal* among "the 100 best technical books of the year."

Starting with an easy-to-read chapter on what the diesel engine is, the text progresses through distinguishing features, basic construction, physics and engineering terms, heat and combustion, oil and gaseous fuels, engine power and fuel consumption, rating and performance, engine types, stationary parts, major moving parts, valve gears and scavenging systems, fuel injection and combustion, lubrication, governing, typical diesels, high-compression gas-burning engines, auxiliary systems, operation and maintenance.

An introduction to each chapter gives the reader a glimpse of what is to come and helps him relate this material with what he has previously learned. The text is so well organized throughout that all engineers dealing with diesel and high-compression gas engines will find the book an excellent aid—either for fundamental grounding or a quick review.

Modern Physics for the Engineer. *Edited by Louis N Ridenour, vice-president, International Telemeter Corp; 19 contributors. 6x9, 499 pp, illus, tables, $7.50. McGraw-Hill Book Co, 330 W 42nd St, New York 36, N. Y.*

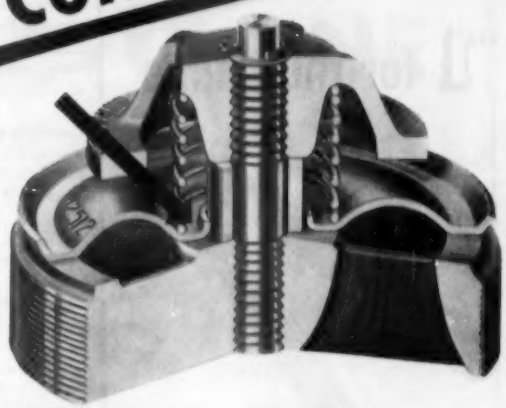
This collection of lectures was delivered to an extension course at University of California, Los Angeles, during 1952-1953. The book is arranged in three parts: laws of nature; man's physical environment; information and its communication.

The first part covers physics in its more narrow definition—what we know of matter, radiation and the laws of their interaction. The second part deals with application of physical laws and techniques of investigation used in studying the universe, earth and air. The third section is concerned with the application of physics to electronics.

The book is offered with the idea that present day discoveries in science find applications in practical engineering very quickly. For this reason the professional engineer should keep himself informed on today's rapid developments and discoveries in pure science.

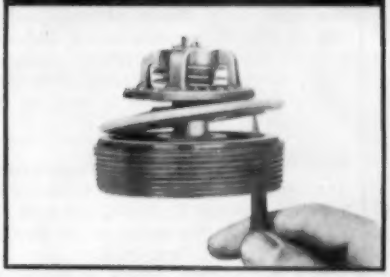
The broad nature of the book is shown by the individual chapter (lecture) headings: relativity and the foundations of mechanics; atomic structure; physics of the solid state; magnetism; microwave spectroscopy; nuclear structure and transmutation; electronuclear machines; actinide elements and nuclear power; elementary particles; astrophysics; high-pressure phenomena with applications to geophysics; the earth beneath the sea; thunderstorms

HOW "POINT CONTACT"



opens the way to pump valve efficiency

DURABLA VALVE



Apply pressure to the outside edge of the valve member with a pencil point. Notice how it tilts and opens with a light pressure, without noticeable friction.

ORDINARY VALVE

Now try this with an ordinary valve. If the valve opens at all, it will only open part of the way, and with excessive friction.

All reciprocating pump valves are subjected to flow forces which necessitate tilting of the valve member while opening. In applying pressure through the seat with a pencil point to the outer edge of the valve member you approximate operating action.

In a DURABLA Valve only "point contact" is made by the valve member on the stud or sleeve, so it cannot bind or hang-up on the guard stem, but opens with a tilt-action following the flow line. Other types of valves using wings for seat guiding or high hubs for stem guiding, cannot avoid creating excessive wear and friction, with resultant warpage and possible breakage of valve or stud.

The unique DURABLA Stainless Steel Valve will operate freely under extremes of high or low temperature, with highly corrosive fluids, and in any position. It will handle vacuums of one micron or discharge pressures of thousands of pounds per square inch. Standard equipment on many pumps, it will fit ANY pump, old or new. Ask for bulletin PR-1.

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2 for the shelf"

Saves you time . . .
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Reduce maintenance time on boiler water-level gauges. For every gauge in your plant, order *two* spare gauge glasses.

Why? Here's why:

Spare No. 1 is handy for you when you need a gauge glass for regular replacement during routine maintenance.

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Normal conditions (Up to 100 p.s.i.)	CORNING brand standard gauge glasses
Higher temperatures	PYREX brand high-pressure gauge glasses
Higher pressures	PYREX brand heavy-wall gauge glasses
Extra visibility	PYREX brand red-line gauge glasses
Viewing inside furnace, reactors, pressure vessels, etc.	PYREX brand sight glasses
Lubrication inspection	PYREX brand lubricator glasses
Visible discharge	PYREX brand oil-cup glasses

Your Industrial Distributor has the best —gauge glasses by Corning. Call today!

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Corning means research in Glass

More BOOKSHELF

Begins on page 247

and lightning strokes; transient phenomena in supersonic flow; electrons and waves; semiconductor of electronics; communication theory and transmission of information; computing machines and processing of information.

Compressed Air Handbook (*Second edition, 1954*). *Compressed Air and Gas Institute. 6¼x9, cloth, 417 pp, $8.00. McGraw-Hill Book Co, 330 W 42nd St, New York 36, N. Y.*

This is a comprehensive and practical guide detailing information necessary to the most efficient and economical use of compressed-air power in a wide variety of industrial applications.

Its six sections cover typical applications of compressed air and gas, air-operated portable tools and rock drills, the compressed-air system, positive-displacement compressors, dynamic-type blowers and compressors, and compressed-air engineering data and test procedure.

Well illustrated, the handbook covers theory, application, selection, installation, testing and maintenance of equipment. Supplementing these facts is extensive practical case-study information. Extensive changes make this edition almost an entirely new book. Recent advances, including centrifugal compressors, are discussed in the revised and additional material. Every power engineer dealing with compressed air should have a copy of the handbook on his desk.

Past Examinations for Professional Engineer—New York State. *Compiled by John Constance, P.E. 11x8½, paper, 88 pp. $1.50. Published by author at 625 Hudson Terrace, Cliffside Park, N. J.*

This compilation covers examinations from January 1943 through June 1953—21 in all. Actual examination papers are reproduced for all three parts.

A study of past problems is helpful in acquainting the candidate with the type of questions he is expected to be able to answer. While the compilation contains only New York State exams, it should prove a good source of practice problems for engineers in other states.

A third 140,000-kw turbogenerator at Cleveland Electric Illuminating Co's Eastlake power plant has boosted capacity to 420,000 kw and Illuminating's system capacity to 1,564,000 kw.

Construction of a fourth unit will increase electric energy output 40,000 kw at California Electric Co's Highgrove generating plant. The $5,393,000 project, scheduled for completion in Nov, 1955, will boost total plant output to over 140,000 kw.

Curtis Manufacturing Co, St Louis, Mo, is celebrating its 100th anniversary. The company's diversified line includes: air compressors, air hoists and power cylinders, industrial clutches and clutch disks for trucks and tractors.

The last word . . . on packing will be in

Power's

special report "Mechanical Packing" coming in March.

24 pages expertly organized, generously charted and illustrated. Reprints will be available.

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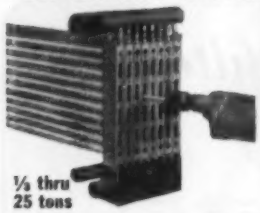
Only Halstead & Mitchell can offer a 20-Year Guarantee on the wetted deck surface against rotting and fungus attack *because* only Halstead & Mitchell pressure-creosotes cooling tower wood. No other material, subject to deterioration or rusting, can offer this long life.

Stainless steel fans and shafts, sheet steel cabinets hydraulically painted with vinsynite, vinyl zinc and chlorinated rubber . . . provide protection for the longest life. There's no extra cost for these extras . . . just extra long time benefits on the job.

H&M CLEANABLE CONDENSERS ADD YEARS OF LIFE, TOO!



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Your cooling tower works with a condenser, and Halstead & Mitchell is the world's largest manufacturer of double-tube, counterflow CLEANABLE condensers. You maintain heat transfer efficiency at new unit level with easy cleanability. Why settle for less?

Write for Cooling Tower Catalog WT & CT 583, Condenser Bulletin C-3

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AT LEADING WHOLESALERS EVERYWHERE

This Adams CYCLONE Saves You MONEY!

The Aftercooler and Separator that assures

DRIER Compressed Air

Here's real teamwork! First, the Adams Aftercooler brings the compressed air temperature down — within 10 of the cooling water — where it holds almost 40% less moisture than air from conventional units.

Then, the Adams Separator creates a cyclone to efficiently remove the condensate . . . giving you cooler, drier air for your system.

Thousands in use throughout industry. It will pay you to find out all the details. Mail the coupon below today.

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Want to save $30,000 a year...automatically?

New, wind operated automatic controller energizes forced draft or heat systems under unfavorable meteorological conditions . . . thus shutting off scrubbers when not needed. It's called the Bendix-Friez Windtrol.*

If you're one of those plants that takes its community public relations seriously, when it comes to air pollution...

And if you keep your scrubbing equipment operating continuously to forestall air pollution . . .

Then we've got some good news for you.

The established principles of stack meteorology, based on Bendix-Friez case histories, can save you as much as $30,000 a year.

Unfavorable Quadrants

By checking wind speed and direction, the unfavorable quadrant for stack effluents can be discovered and controlled automatically. This unfavorable condition of air pollution may be only 25% of the time.

Shut Off Automatically

Thus, instead of running your scrubbers constantly at a cost of $40,000 . . . they are shut off automatically by the Windtrol Transmitter.

Easily installed. The transmitter is at stack height. The controller is located indoors on any convenient wall.

How It Works

The transmitter of the Windtrol has been constructed so that the controller circuit is energized when the wind speed is less than a selected value, and the wind direction is from a specified arc. Normally, it is wired so that both conditions must exist simultaneously for the circuit to be energized.

Observations indicate that many situations will arise because of the gustiness of the wind in which either or both, the direction and speed will oscillate rather rapidly in the vicinity of the selected limits. This could result in intermittent and short period closures of the controlling circuit, were it not for a built-in time delay device which causes the actuating power relay to remain open or closed for a given length of time after the direction or speed has changed from the required limits.

For Further Information . . . Write Today.

* REG. U.S. PAT. OFF.

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This is a General Blower forced draft installation. It is one of many heavy duty General applications being specified every day by architects and engineers all over America.

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• Backward blade centrifugal fans • Forward curve centrifugal fans • Util-A-Vent sets • Roof ventilators • Axial flow fans • Propeller fans • Fume exhausters • Turbo pressure blowers • Gas boosters • Steel plate type industrial fans

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Condense and filter
...if you want "INSTRUMENT-QUALITY" Compressed Air

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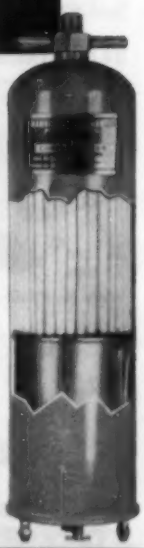

Sets years-ahead filtering standards. When your problem involves Clean, Dry, Air to obtain more efficient, dependable instrument operation, the Hankison Condensifilter offers you a practical low cost solution.

Hankison Condensifilters give greater overall efficiency through three engineering extras •

- Twin Action Principle, that both filters and dehydrates.
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See why maintenance men are specifying Condensifilters. A qualified engineer is available to consult with you on all compressed air problems.

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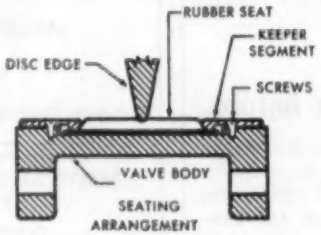
Now!..Bottle-Tight Butterfly Valves in ratings to 125 P.S.I.

Corrosion cannot hinder operation . . . Even if not operated for long periods, a Henry Pratt Butterfly Valve will open or close easily. These valves are not subject to "corrosion seizing" because all seating surfaces are non-corrosive. The disc edge is either stainless steel or chrome-plated, and it closes into a thick rubber seat. These features, coupled with Oilite bearings and stainless steel shafting, make it impossible for valves to "corrode tight" either open or shut.

Full 90° closure into Rubber Seat . . . The disc diameter is slightly larger than the inside diameter of the rubber seat and thus when rotated to the full closed position the disc actually displaces the rubber. This seat has been designed so that the ratio of seat thickness to disc indentation insures bottle-tight shut-off while minimizing permanent set and excessive abrasion.

The resilient seat material is reinforced by heavy canvas insertions to increase seat strength. The seats are secured in the valve body by removable keeper segments.



Before shipment all valves undergo rigorous leakage tests to insure compliance with leakage guarantees.

Sound design features in both low and high pressure ratings . . . Valves are manufactured in sizes from 10 to 168 inches in diameter. Valve construction can be either cast iron or fabricated steel. Operator types available include hand wheel, chain wheel, limitorque electric motor, hydraulic cylinder, air cylinder, etc. All Henry Pratt Rubber Seat Butterfly Valves are suitable for an operating temperature range of −20° to +190°F.

54" Limitorque electric motor operated, low pressure standard rubber seat butterfly valve.

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"Understanding Butterfly Valves", Bulletin 2-K
Low Pressure Valves, Bulletin 1-K
High Pressure Valves, Bulletin 4-K

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PALMETTO Packings

NOTE: For the name and location of the Palmetto distributor nearest you, see Greene, Tweed's two-color insert at the head of the packing section in Thomas' Register.

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FINANCIAL AID TO HIGHER EDUCATION

Business Aid for Our Colleges—Voluntary or Involuntary?

Previous editorials in this series have shown that:

- As a group the nation's independent, privately endowed colleges and universities are in grave financial trouble, and
- There are many different means by which business firms can extend a helping hand to these institutions.

This editorial, one of a series devoted to the financial problems of higher education, submits this proposition: **If business firms do not voluntarily go to the financial aid of higher education, there is every prospect that they will soon be providing more financial support for higher education involuntarily, through taxation.**

If this prospect materializes, one of the basic elements of a well-balanced system of higher education—a strong array of independent colleges and universities—may well be dangerously weakened if not destroyed. And in the process a potentially crucial bulwark for freedom of enterprise in the United States—that same strong array of independent colleges and universities—will be undermined.

Acceptance of these propositions implies absolutely no disparagement of tax-supported colleges and universities. These have an indispensable role in the total system of higher education in the United States. Leaders of these institutions would be among the first to agree that their position is strengthened by a strong system of independent institutions, supported privately rather than by political agencies.

What is the evidence that in one way or another, voluntarily or involuntarily, business will be giving more financial support to higher education? One impressive part of this evidence is provided by the recent rapid increase in the proportion of college and university students attending tax-supported institutions.

Rapid Shift in Enrollment

In the fall of 1952 tax-supported colleges and universities enrolled about 7.5 per cent more students than the independent institutions. In 1953 this percentage was doubled. And in 1954 the tax-supported institutions enrolled 26 per cent more students.

In the case of students entering college for the first time the relative growth of the tax-supported institutions recently has been even more striking. In 1952, the number of beginning students in the tax-supported schools, as reported by the U. S. Office of Education, exceeded those in the independent colleges and universities by 35 per cent. In 1954, just two years later, this figure jumped to 49 per cent.

Why has the proportion of students attending tax-supported colleges and universities been in-

creasing so rapidly? There are many reasons. But a dominant reason is that, in order to keep going at all, the independent institutions have been forced to make large increases in the prices they charge for instruction. The purchasing power of their endowment funds has been cut in half by price inflation. The capacity of the wealthy to supplement their endowments by gifts, as they have done in the past, has been greatly reduced by high taxes. As a result these schools have been forced to rely increasingly on higher prices for instruction (tuition as it is called in academic circles) to make both ends meet.

Since 1940, the independent colleges and universities have raised their tuition fees by an average of about 60 per cent. This is considerably less than the increase of about 100 per cent in prices generally since 1940. And it is nowhere near enough to prevent the faculty members of the independent colleges from faring miserably in terms of salaries, a matter of major national importance to which we shall return in this series. But the increase in tuition fees of the independent colleges has been much greater than the increase in the fees charged by the tax-supported schools. And that price differential increasingly tends to shunt students into the schools which are supported chiefly by taxes. Independent colleges now charge, on the average, about $580 per year for a full course of instruction while the tax-supported institutions charge, on the average, about $240.

Bigger Tax Bill in Prospect

A large increase in the total enrollment in our colleges and universities during the next decade is in prospect, particularly when the great increase in births during World War II is reflected in the number of young men and women of college age. With a total of 2.5 million students at present enrolled in our institutions of higher learning, it is estimated that the total will be over 3 million by 1960.

If this trend continues most of the anticipated increase in college and university enrollment will be concentrated in tax-supported institutions. Indeed, if the shift toward tax-supported institutions that has occurred in the last three years were to continue over the next six years at the same rate, about two million of the three million students anticipated in 1960 would be in tax-supported colleges and universities and one million in independent schools. In 1950 there was a 50-50 division in enrollment. This shift would mean, of course, a corresponding increase in the tax bill for tax-supported education. And of this bill, we can be sure that an ample share would be assessed against business firms.

No Easy Solution

The best way, of course, to put a brake on a soaring tax bill for higher education is to help the independent institutions get in shape financially to carry a larger share of the student load. For most companies the development of a mutually satisfactory program of financial aid for higher education is a complicated process. In fact, it is so complicated that some companies with an initial disposition to provide financial help are inclined to despair of working out a mutually constructive plan.

If, however, the leaders of business will contemplate seriously the only available alternative to their extending voluntary help to our independent colleges and universities, their determination to work out a plan will be strengthened. For that alternative involves a grave weakening of our system of higher education, together with an involuntary increase in the financial support of higher education by business. The increase would come through higher taxes. Contemplation of such an alternative should, if necessary, toughen the will of business firms generally to do everything possible to extend financial help to our independent colleges and universities.

This message is one of a series prepared by the McGraw-Hill Department of Economics to help increase public knowledge and understanding of important nationwide developments that are of particular concern to the business and professional community served by our industrial and technical publications.

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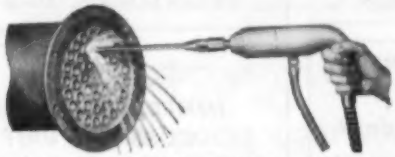

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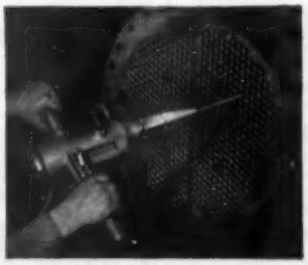

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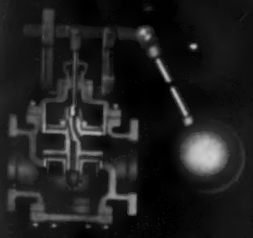

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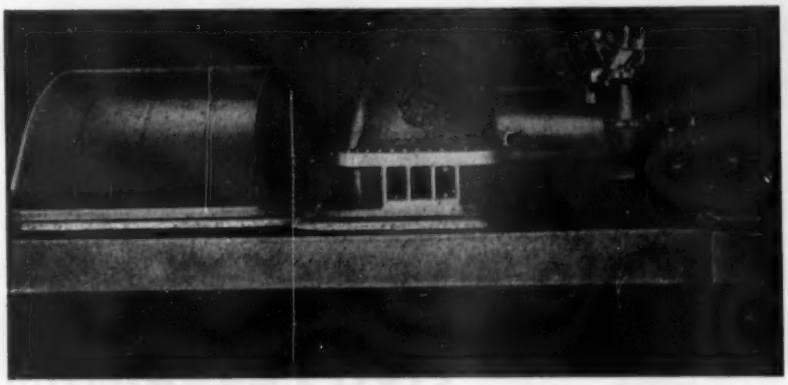

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2	3750	G.E. New	OISC	3	26400x4160
1	1000	G.E.	Auto	3	4150x2400
1	1000	Amer.	OISC	3	4150x450
1	750	G.E.	HT	3	4150x120/240
2	750	G.E.	H	1	4600x120/240
1	500	Kuhl	OISC	1	4600x2300
2	400	Pitts.	OISC	1	4150x240/480
1	333	G.E.	H	1	13200x220/440
3	300	G.E.	H	1	13200x440
1	200	G.E.	HT	3	2400x240
1	200	G.E.	H	3	4150x2400Y
2	150	Pitts.	ODSC	1	230x115/230
3	100	Wagner	HEB	1	440x120/240
1	50	Whse.	S	1	2400x120/240
1	50	Amer.	OISC	1	13200x220/440
3	50	G.E.	H	1	440x110/220
3	50	Whse.	S	1	2400x240/480
3	50	G.E.	H	1	2300x115/230
1	50	G.E.	H	1	2300x110/220
3	37½	G.E.	H	1	2400x120/240
1	37½	G.E.	H	1	13800x230/460
3	25	Niagara	OISC	1	4160Yx480
1	25	Moloney	HE	1	2300x115/230
1	25	Whse.	VR	1	2400x240/480
1	25	Allis	PSSR	1	480x120/240
1	10	Packard	A	1	650x110
1	10	G.E.	H	1	220/440x110/220

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1	1000	Whse.	720	600	2300/4150 3yn
1	1000	Whse.	720	275	2300/4150 3yn
1	300	G.E.	1200	250	2300/4150 3ph
1	300	G.E.	1200	250	2300/4150 3yn
1	200	Whse.	900	250	2300/4150 3yn
1	150	G.E.	1200	125/250 3 unit	2300 3yn
1	100	G.E.	900	250 1 ph	2300 3yn
3	97	G.E.	1200	60	4150 3yn
1	75	G.E.	1800	250	230/440 3ph
1	60	Whse.	1200	60	2300 V
3	60	EM	1200	125	220
1	50	Whse.	900	230	440
1	30	G.E.	1750	240	220/440
1	25	G.E.	1800	230	220 V 3yn
1	20	EM	1800	125	230 V
1	7½	Allis	1800	125	220/440
3	5	G.E.	1800	125	220/440
2	1½	G.E.	3600	800 cy	220/440

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QU	HP	Make	Speed	Type	Volts
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1	400	Whse.	450	HR	550
1	350	Whse.	450	HR	440
1	300	EM	720	TEFC	2300
1	300	G.E.	600	ATI	600
1	200	Whse.	600	ATI	240
1	175	G.E.	720	AT5	2300
3	150	G.E.	1200	TS	4150
1	150	G.E.	1800	TS	220
1	150	Whse.	900	181C	220
2	150	Allis	360		2200
1	125	EM	900		4800
1	100	G.E.	514	TS	2200

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QU	HP	Make	Speed	Type	Volts
1	500	G.E.	1200	M	2400/4150
1	400	Whse.	450	CW	550
1	250	Whse.	60	CW	440
2	200	Whse.	600	CW	440
1	200	G.E.	600	MT	440
1	150	A.C.	1800	AY RW	2300
1	100	G.E.	1800	IM	220
1	100	G.E.	600	IM	440
1	75	G.E.	600	IM	440
3	60	G.E.	1800	MT	220
1	60	G.E.	900	MT 546	440
2	50	G.E.	1800	MT527	220/440
1	50	G.E.	1350	MT536	220/440
2	50	Whse.	900	CW	220/440
2	50	G.E.	860	MT	220/440

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Qu	HP	Make	Speed	Type
1	200	G.E.	1200	MPC
2	150	C.W.	900	WP
1	125	G.E.	1700	RC
2	75	C.W.	900	WP
1	30	C.W.	700	CM
1	25	G.E.	880	RC
1	25	Whse.	835	SK

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26	1500	West.	525/600	600 RPM
32	1500	Al. Ch.	525/600	675 RPM
4	1200	Al. Ch.	525/600	650 RPM
2	900	Elliott	230	900/195 RPM
3	800	West.	525/600	600/900 RPM
1	650	Cr. Wh.	230	475/720 RPM
1	500	West.	230	350/500 RPM
1	450	West.	230	400/1200 RPM
1	400	G.E.	230	480/360 RPM
7	400	Elliott (new)	230	400/900 RPM
6	400	West. (new)	230	375/750 RPM
2	350	Cr. Wh.	230	400/800 RPM
1	300	Cr. Wh.	230	900/750 RPM
1	200	Cr. Wh.	230	375/750 RPM

All motors designed for mill reversing service. Smaller sizes also in stock.

Motor Generator Sets in Stock 100—2000 KW Capacity

All of above is modern late type equipment remanufactured & tested by our engineers.

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50 CHURCH ST. NEW YORK 7, N. Y.

Plants: SAUSALITO (S.F.) CALIF., JERSEY CITY, N. J.

MOTORS!

Amt.	HP.	Speed	Make	Type	Frame
3	250	600	G.E.	KT568 (2300V)	
1	200	900	A-C	AR830D	
1	150	1800	Whse.	CS (2200V)	817S
2	150	1800	A-C	2EP-226-43-10	
2	150	1800	A-C	AWW	23B86
1	150	600	G.E.	I-K (2200V)	
1	125	1200	Wag.	26WBP	
1	125	1800	Whse.	CS	4 Mil.
1	100	1800	Howell	K (TEFC)	
1	100	1800	Whse.	CS	663C
1	100	1200	Whse.	CS	752C
1	100	1200	A-C	AR (2200V)	823E
1	100	900	A-C	2200 V 2K20064.1	
4	75	1800	Howell	230-440 V	504U
1	50	1720/575	L-A	Adjusto-Spede	445

SLIPRING

1	100	900	G.E.	MT326	
1	100	450	G.E.	I-M (2200V)	16
5	75	720	A-C	(1-2200V), 1-440V	
2	75	900	G.E.	I-M	

PARTIAL LISTINGS—10,000 OTHER MOTORS IN STOCK—NEW & REBUILT—A.C. & D.C. NEW MOTORS AT LONG DISCOUNTS

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3—200 KVA 4000/2300 x 460/230/115 v.

3—50 KVA, 4200 x 440/220.

All with taps.

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Diesel-elec. generator sets, 302 KW to 1000 KW. Marine diesel engines, 220, 500, 950, 1000 HP. Portable cranes, Whirley, crawler, track type. Colby traveling hammerhead crane, 145' reach. Euclid diesel end & bottom dumps, 15-22 tons. Turbo-generator sets, 1000 KW, 625 KW. Power shovels, draglines, diesel, 2 to 12 yds. Locomotives, 10 to 100 tons, std. & 36" gauges. Rotary dryers, Kilns: 8x125, 7x125, 6x110, 5x67.

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8,100 KVA DIESEL POWER PLANT

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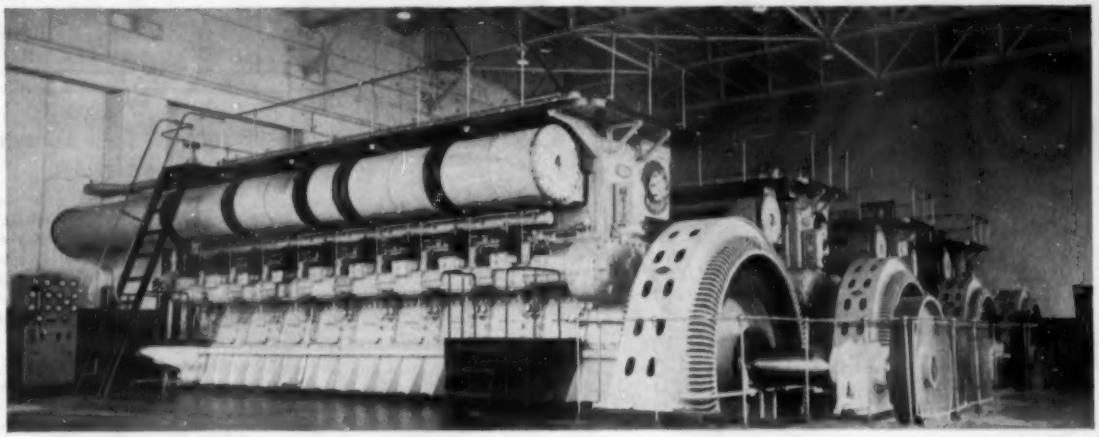

THREE (3) BUSCH-SULZER (NORDBERG) DIESEL ENGINES, 3060 HP, 9 cylinder, 2 cycle, 240 RPM, Type 9 DHB-27, direct coupled to:

THREE (3) 2700 KVA, E. M. C. Alternators, .8 PF, 2160 KW, 3/60/2300/4160 volts, with 30 KW, 125 volts, V-belted Exciters.

EACH UNIT COMPLETE WITH:

Burgess Air Intake Silencer
Burgess Exhaust Silencer with heating coils
American Air Filter
Ross Heat Exchanger
Starting Air Compressor & Tank
Lube Oil Transfer Pump & Motor
Jacket Water Pump
Raw Water Pump
Hot Water Circulating Pump
Flow Meter, temperature control, strainer & thermometer
Engine Control Panel, Gauge Board & Alarm System
Fuel Oil Transfer Pump & Motor
Fuel Oil Transfer Pump, manual
Oil Cooler
Woodward Governor
250 gal. Fuel Oil Day Tank
Westinghouse metal clad Switchboard with Air Circuit Breaker

AUXILIARY EQUIPMENT:

20,000 CFM Sturtevant Fan #105 with 10 HP motor & starter.
Lube Oil Purifying Plant—Youngstown Miller, Model AV-110, rated 120 gal. per hour.
2—150 GPM Fuel Oil Unloading Tanks with motor.
2—12,500 BBL. welded, Oil Tanks, 48' x 39' high.
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2—300 KVA Westinghouse OISC Transformers 3/60/4160—480/240

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In excellent Condition

Non-Condensing, Steel case 80# back pressure .8 P.F., 3 phase, 60 cycle, 4160/2300 volts, alternating current, complete with accessories, switchboard, oil circuit breaker and direct connected exciter. Only operated alternately for six years. Ideal for Chemical, Rubber, Petroleum, Textile, Pulp and Paper, and Sugar Refining Industries.

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200 KW General Motors Model 8-268A, 8 cyl., 3/60/440 volts, 1200 RPM. Inc. Switchboard & accessories.

100 KW G.M. Model 3-268A, 3 Cyl., 2 Cy., 3/60/440 V., 1200 RPM. Panel.
Overhauled. Other sizes in stock

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STerling 3-6515

3 G. M. 200 KW DIESEL GENERATOR SETS

Reconditioned by U.S. Navy

EQUAL TO NEW

Complete with motor driven starting air compressors, air tanks, dead front type generator switch panels and all other necessary accessories.

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G.M. Model 8-268A—6½X7—1200 RPM—air starting—complete with engine operating panels, heat exchangers, cooling pumps, filters, strainers, governors, pyrometers, etc.

GENERATORS

Westinghouse 200 KW 250 KVA—440/3/60—1200 RPM—80% P.F.—continuous—drip-proof enclosure—direct connected exciter.

SIZE AND WEIGHT

Each unit, mounted on a pre-fab sub-base, is 13' 0 5/16" long, 5' 10½" wide, approx. 8' high. Weight of engine and generator only, 17,705 lbs. Each unit, with all accessories, about 27,000 lbs.

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No expense has been spared to put these 3 units in "equal to new" condition. Don't miss this opportunity to buy! Inspection can be made at our warehouse, Curtis Bay, Baltimore.

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COMPLETE POWER PLANT

4—1285 HP B. & W. Boilers, rated #225 psig steam, A.M.S.E. code, lower tubes retubed in 1952, C/W underfed stokers, boiler feed pumps, blowers, Cochrane Heater, pipes, valves, etc.

1—15,000 KVA G.E. Turbo-Gen. Set, type ATB-4, 3 ph., 60 cy., 9000 v., 1800 R.P.M., d/c to a Curtis Condensing Turbine, #200 psig steam, 20,000 sq. ft. Surface Condenser and all other equipment.

1—Skip Hoist Unit, 60 cu. ft. electric driven with 70 ft. Elev. Tower and Cone Shaped Steel Storage Bunker, Catenary Suspension for truck or car loading. Complete.

1—15 ton Link-Belt Std. gauge, 8 wheel, Steam Locomotive Crane, new 1931.

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TURBO-GENERATOR (CONDENSING)
WESTINGHOUSE

1875 K.V.A., 250 lbs. pressure, 150 superheat, 480 volts, 3 phase, 60 cycle, complete with all auxiliary equipment.

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1200 KW MOTOR GENERATOR SET

1—1200 KW General Electric generator, 250 volts, direct current, 720 RPM direct connected to
1—1700 HP General Electric synchronous motor, 3 phase, 60 cycle, 2300 volts, 720 RPM.
New 1925—Excellent Condition

INTERNATIONAL POWER MACHINERY CO.
1618 Union Commerce Bldg., Cleve. 14, O.

400 KW NON-CONDENSING TURBINE GENERATOR

500 KVA—400 KW, 80% PF Allis Chalmers generator, 3 phase 60 cycle, 480 volt, 1200 RPM connected through reduction gear to a:

400 KW Terry non-condensing turbine, 325-400#, 100-125# gauge back pressure, 3800 RPM. Direct connected exciter, switchboard, instruments, spare parts. RECONDITIONED.

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PORTION OF ENGINE REMANUFACTURING FLOOR AND ONE OF THE ENGINE TEST STANDS AT OUR SAUSALITO, CALIF. PLANT

A PARTIAL LIST OF OUR INVENTORY

KW	MAKE	MODEL	HP	RPM
1180	Worthington	SEH-8	1685	360
1136	Fairbanks Morse	38D	1600	720
1100	General Motors	16-278A	1600	720
750	General Motors	12-567	1080	720
700	Worthington	EE-8	1000	327
600	General Motors	12-567	900	600
*500	Alco	6-12½x13T	750	600
500	General Motors	8-567	720	720
*350	Baldwin	VO-6	510	450
320	Superior	60-S-6	460	450
*320	Enterprise	DSG-6	460	450
300	General Motors	8-268A	450	1200
200	General Motors	8-268A	350	900
*160	Buckeye	80	240	600
*150	Worthington	CC-4	225	450
148	Fairbanks Morse	32E14	225	300
100	General Motors	3-268A	150	1200
60	General Motors	6-71	90	1200

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STANDARD AND SPECIAL VOLTAGES AS REQUIRED
*—*Indicates NEW unit*

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1000 KW NON-CONDENSING TURBINE GENERATOR

1250 KVA—1000 KW, 80% PF, General Electric alternating current generator, 3 phase 60 cycle, 2300/480 volt, 3600 RPM, direct connected to a:

1000 KW General Electric non-condensing steam turbine, 125-150#, 10-15# gauge back pressure.

Direct connected exciter, switchboard, instruments and spare parts.

UTILITIES MACHINERY CORP.
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Many years experience and service in POWER EQUIPMENT

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Boilers	Motor Generator Sets	Oil & Air Circuit Breakers
Transformers	Frequency Changers	Feeder Voltage Regulators

Your inquiries stating your needs will receive our careful and prompt attention

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DIESEL ENGINES & POWER PLANTS

32-E-12 F&M 12x15, w/8x8 York, 360 RPM $1850
32E F&M 2 cyl. 14x17, w/generator 1950
32E F&M 2 cyl. 14x17, w/clutch 1750
35E F&M 6 cyl. 8¾x10, 180 HP 1000
120 HP Atlas 6 cyl/w/clutch, rad. skids 1350
400 HP nat. gas Gen. Motors, 6 cyl. 8x10 3250

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2—20 KW Ideal, Engines Waukesha MZB, Ea. $1150
2—0.5 KVA, New, gasoline driven Ea. 785
1—20 KW Lorimer, diesel driven 1000
1—15 KW Hill diesel, single phase 1125
1—35 KW, D-4600 Caterpillar Diesel 1500
1—100 KVA, Mod. D-1742 Buda diesel 3000
1—300 KW, Mod. 8-268A General Motors 12000

Largest stock of miscellaneous power equip. Engines, generators, elec. motors, switchgear in Heart of America.

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SLIP RING MOTORS

3 phase, 60 cycle, 220 or 440 volts (*2300 volts or higher)

H.P.	Make	Type	Speed
1500	*G.E.	MT-56	240
1250	*Westg.	CW	600
1000	*Westg.	CW	250
700	*Al-Ch.	ANT	720
600	G.E.	MT-567	1200
600	*Westg.	CW	450
500	*G.E.	I-P	257
500	Westg.	CW	250
400	Al-Ch.	8 brg.	450
400	*G.E.	MT-412	450
400	*G.E.	IE-12A	1800
300	*G.E.	MT-568	720
250	Westg.	HP-15H	600
200	*Westg.	CW	1200
200	G.E.	IK-15B	900
200	G.E.	IM	600
150	Cr. Wh.	50-B	1800
150	G.E.	MT-549	1800
150	*Al-Ch.	ANT-30F1	1200
150	Westg.	CW-568A	720
125	G.E.	IM-15A	900
100	G.E.	IT-15A	1800
100	G.E.	IM	900
100	G.E.	IM	450
75	Nor. West.	HW-50	1800
75	G.E.	MT-547	1200
75	G.E.	IM	1200
75	Al-Ch.	ABT-223C	1200
75	G.E.	MT-556	900
75	Al-Ch.	ANT-36F	900

SLIP RING MOTORS

Crane and Hoist Service
3 phase, 60 cycle, 220 or 440 volt

H.P.	Make	Type	Speed
75	Westg.	GE-756A	600
50	Westg.	MW-554	600
50	G.E.	HIC TENV	600
25	G.E.	MTC-5536	600
22	G.E.	ITC-5009	1200
20	Westg.	CI	1200
15	G.E.	ITC-5010	720
11	Westg.	CI-E464	900
10	F & H	BW-6	1800

SYNCHRONOUS MOTORS

3 phase, 60 cycle, 220 or 440 volt (*2300 volts or higher)

H.P.	Make	Type	Power Factor	Speed
1429	*West.		.7	900
720	*West.		1.0	900
710	*G.E.	ATI	1.0	720
600	*G.E.	TS-7640	1.0	900
560	*G.E.	TS-7637	1.0	514
450	*West.	H	.8	1800
400	West.	HG	1.0	900
300	G.E.	ATI	.8	900
300	G.E.	ATI	.8	720
300	*Ideal	SMM	.8	257
300	G.E.	ATI	.8	1200
250	G.E. New	TS-9747Y	.8 (3brg)	720
225	G.E.	TS-6344	1.0	360
225	El. Mch.		1.0	360
200	F-M	TJC-285	.8	720
150	El. Mch.		1.0	720
150	F-M	TJC-285	.8	720
150	G.E.	ATI	.8	720
150	*El. Mch.		.8	1200
150	Westg.	HR	1.0	300
125	*G.E.	TS-7641	1.0	514
125	*G.E.	TS-6314	1.0	277
125	*El. Mch.			900

D. C. MOTORS—230 Volt

H.P.	Make	Type	Speed
250	Westg.	SK-220	450/600
250	Westg.	SK-201	600
200	Cr. Wh.	CM	600
175	G.E.	ELC	750
160	G.E.	MPC	400/800
100	G.E.	BC-24	2300
100	G.E.	CDP-115	1750
100	G.E.	RC-19	575
100/150	G.E.	MCP	200/1000
75	G.E.	BCP-24	1750
50/120	G.E.	MCP	250/1000
50	G.E.	BC-31B	1700
50	Cr. Wh.	CMC	700/1100
50	G.E.	DLC-204	450
35	Westg.	SK-150	250/1000
30	Cr. Wh.	CCM-504	450
30/40	G.E.	CD-115	500/1500
25	G.E.	BC-32	800

MOTOR GENERATOR SETS

K.W.	Make	11000	137/275
1000 (3u)	Westg.	2300	137/275
500	Westg.	A.C.	D.C.
500	Westg.	2300	275
400	A.C.	2300	120/240
300	G.E.	2300	250
300	G.E.	2300	250
300	Westg.	4160	250
200	Ridgeway	2300	250
179	G.E.	440	125
150	G.E.	2300	125/250
150	G.E.	4000	250
150	A.C.	2300	275
150	G.E.	440	275
100	Westg.	440	125
100	El. Mch.	440	125
100	G.E.	240	250
100	G.E.	440	125
60	G.E.	440	60
75	G.E.	440	125
60	Westg.	2300	125
60	A.C.	2300	125
50	Reliance	440	250
50	Ideal	2300	250
50	Westg.	240	125
40	G.E.	440	125
40	G.E.	440	250
35	Westg.	2300	180
30	G.E.	440	125
30	Westg.	2300	125
25	L-Allis	440	250
25	Bogue-GE	550	250
20	Bogue-GE	220/440	250
20	Bogue-GE	440	125
15	Westg.	220/440	250

PUNCH PRESS MOTORS

NEW—S/60/220-440 volt
High Torque—High Slip

H.P.	Make	Type	Speed
60/45	G.E.	KH-6325	1000/790
60	Westg.	CS-752-C	1000
60	Westg.	CS-857-C	1685
50	Westg.	CS-505	1000
50	Imperial	E-1584	1000
40	Reliance	AA-B-506	1635
40	Imperial	E-505	1000

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40.6 CFM 3500 psi 3 stage Ingersoll Rand 25 HP
122 CFM 100 psi 7x7 Worthington HB 20 HP Elec
125 CFM 100 psi 6½x4½ Davey VB5 6 available
142 CFM 125 psi 6/6/8x8 Worth M-25 25 HP Elec
254 CFM 125 psi 10x10 Ingersoll ER-1 40 HP
268 CFM 500 psi 10x4½x10 Ingersoll XCB 75 HP
270 CFM 125 psi Joy WL-90 2 available
278 CFM 125 psi 2 Stage Chicago PB 50 HP Elec.
285 CFM 125 psi 2 Stage Gardner "WB" 50 HP
291 CFM 140 psi 3 cylinder Ingersoll Type 40
294 CFM 125 psi 10x11 Chicago T-B 2 available
312 CFM 100 psi 4 cylinder Gardner "AAG"
343 CFM 500 psi 11/8x13 Worthington HB2
364 CFM 120 psi 12x7 Gardner "RX" 2 Available
552 CFM 125 13/8x10 Ingersoll 100 HP Elec
560 CFM 125 psi 2 stage Chicago PB8 100 HP
676 CFM 100 psi 15-9¼x12 XCB 1R
931 CFM 55 psi 17x13 Chicago T-B Steam or Elec.
1065 CFM 35 psi 20x12 Penn 3-A 100 HP Elec
1574 CFM 100 psi 22/14x10 PRE 2—1R—(3) stock
1575 CFM 90 psi 15/10x14 Penn DB-1 200 HP
1723 CFM 110 psi "XPV" 4 corner Ingersoll Steam

VACUUM PUMPS (Dry)

354 CFM 14x5 Ing Rand
720 CFM 18x7 Worthington
800 CFM 18x9 Worthington
1635 CFM 24x11 Chicago
5881 CFM 30-30x12 XVH—1R 200 HP—3-60-2300 Sys. (2) available

PORTABLES—15 CFM to 600 CFM
Prompt Deliveries

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DELL AVE & 47th ST
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Do you need a
250 H.P.
LOW PRESSURE
BOILER?
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Cliff Steel, Built Terra Haute, Ind., 1946 —used 5 years (in fine condition) Horizontal Fire Tube, Complete with Petro Oil Burner (#6 fuel oil) 48" Stack Fan and 35' Stack; Protector Relays and Controls; Ignition Transformer Pump, Oil Valves. Boiler and Equipment originally cost $15,000.00.

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FAIRCHILD
Aircraft Division
HAGERSTOWN, MARYLAND

FOR SALE
18 NEW TURBINES
4 horizontal, 14 vertical, Westinghouse

Driving forced draft blowers—capacities ranging from 39000 to 56000 CFM and 16" to 24" pressure. Steam pressures 360 to 575#, back pressure 10#.

Will sell turbines separately if desired. *Price reasonable.*

Also—1—250 KW GE turbo generator unit, 3 phase, 60 cycle, 440 volt. Used one year.

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2457 WOODWARD AVE.
408 DONOVAN BLDG.
DETROIT 1, MICH.

3—333 KVA—1-60-33000 to 2300/4000 V. General Electric outdoor transformers.
6—100 KVA-3-60-2400-120/208 V. Pyranol transformers each with 275 A, 600 V. 3 pole air breaker.
1—150 HP-900 rpm-440-3-60 GE synchronous motor exciter and automatic starter.
1—100 HP-870 rpm-440-3-60 NEW Elec. Mach. Mfg. Co. Magnetic Drive and Regutron Control.
H. BLAINE JOHNSON & ASSN.
53 W. Jackson Blvd. Chicago 4, Ill.

NEW UNUSED
1000 KVA CONDENSING TURBINE GENERATOR

1000 KVA—750 KW, 75% PF, General Electric alternating current generator, 3 phase 60 cycle, 450 volt, 1200 RPM connected through reduction gear to a:

750 KW General Electric condensing steam turbine, 10033 RPM, 375-440#, 740°TT.

UTILITIES MACHINERY CORP.
1965 E. SIXTH ST., CLEVELAND 14, OHIO

RE-NU-BILT
GUARANTEED

ELECTRIC POWER EQUIPMENT

D. C. MOTORS

Qu.	HP	Make	Type	Volts	RPM
1	2200	G. E.	MCF	600	450/600
1	2000	Whse.	Mill	600	230/400
1	1200	G. E.	MCF	600	750/950
1	940	Whse.	QM	250	140/170
1	900	Whse.		250	450/550
1	825	Whse.		250	95/190
1	600	Al. Ch.		250	400/600
1	500	Whse.	CC-216	600	300/900
1	500	G. E.	MCF	230	300/900
2	450	Whse.		550	415
1	300	Whse.	CB-511.3	250	400/600

A. C. MOTORS—3 Ph. 60 Cy.

SLIP RING

Qu.	H.P.	Make	Type	Volts	Speed
1	1500	G. E.	MT-459	2300	300
1	1500	ABB		2300	720
1	1200	G. E.	MT	2300	275
2	1000	A. C.	Mill	2300	240
1	1000	G. E.	MT-452	2200	331
1	800	G. E.	M-574Y	6600	900
1	500	Whse.	CW	550	350
1	400	Whse.	CW-960A	440	1170
1	400	Whse.	CW	440	514
1	400	Whse.	CW-1218	2200	435
1	350	G. E.	MT-442 Y	2300/4000	253
1	350	G. E.	1M-17A	440/2200	720
1	250	G. E.	MT-424-Y	4000	257
1	250	G. E.	MT-5598	2300	1800
1	250	Al. Ch.		550	600
1	200	G. E.	MTP-530	440	1170

SQUIRREL CAGE

2	650	G. E.	FT-559BY	440	3570
2	450	Whse	CS-1420	2300/4150	354
1	300	Whse.	CS	440	1170
1	200	G. E.	IK-17	440	580
2	200	G. E.	KT-557	440	1800
1	150	Whse.	CS-8568	440	580
1	150	Whse.	CS	440	580
1	150/75	G. E.	IK	440	900/450
2	125	Al. Ch.	ARW	2200	1750

SYNCHRONOUS

1	4350	C. W.	3501-SL	13800/6900	514
2	2100	G. E.	ATI	2300	300
8	1750	G. E.	ATI	2300	3600
2	2000	Whse.		2300	120
2	735	G. E.	ATI	2300/12000	900
1	730	G. E.	TS	2300/4000	720
1	500	Ideal	SM	2300/4160	1800
1	500	Whse.		440	900
1	450	Whse.		2300	1285
1	450	Whse.		2300	450
1	400	G. E.	TS	2300	600

M-G SETS—3 PH. 60 CY.

Qu.	K.W.	Make	RPM	DC Volts	AC Volts
2	2000/2400	G. E.	450	250/290	2300/4600
2	2000	G. E.	450	600	2300/4600
1	2000	G. E.	500 25cy	650	11000
2	2000	G. E.	514	600	6600/13200
1	1500	G. E.	720	600	6600/13200
1	1500	C. W.	514	30/115	4000/13000
2	1000	G. E.	720	600	2300/4600
1	1000	G. E.	900	250	6600
1	750	C. W.	514	30/115	2300
1	600	G. E.	720	250	440/2300
1	500	Whse.	1200	115/230	2300

TRANSFORMERS

Qu.	KVA	Make	Type	Ph.	Voltages
1	5000	Whse.	OISC	3	3300x2640
1	2500	Whse.	OISC	3	26400/13200x46
2	2000	G. E.	HVDDJ	1	66000/13800
2	667	G. E.	HD	1	13800x2300
3	1000	G. E.	HVDDJ	1	2400x480
6	1000	Wagner	OISC	1	13200x46

FREQUENCY CHANGER SETS

Qu.	KW	Make	Freq.	Voltages
1	12500	Whse.	60/25	13200/13200
1	3000	G. E.	60/25	2300/2300/4000
2	2500	G. E.	25/62.5	2300/2300
1	1000	G. E.	25/58.3	4400/2300
1	500	Al. Ch.	2560	11000/2300

TURBO GENERATORS

Qu.	KW	Make	Desc.
1	4800	G. E.	Condensing 425—750 P. T. T. Surface Condenser 3/60/2300/4000 V Direct conn exciter
1	1500	Whse.	Auto-extraction 190 lbs.—600° F.T.T. 60 lb. extraction 3/60/240 V. Div. conn. Exc.
1	1000	Moore	Auto-Ext. Cond. 175/200# I.S.P. 5/20# G. Ext. Surface Condenser—3/60/2300.
1	1000	G. E.	Non-condensing 175/200 lbs. I.S.P. 5/20 lbs. G.E.P., 480/3/60.
1	750	G. E.	Condensing 265# I.S.P. 440V. 3 ph. 60 cy.—New—1944.
1	750	Whse.	—Non-condensing 1 5# I.S.P. 40# B.P. 750 Kw. 260 V. D.C.

BELYEA COMPANY, INC.
43 Howell St., Jersey City 6, N. J.

"Certified Rebuilt" Motors and Generators

A. C. GENERATORS — 60 CYCLE

KVA	Mfr.	Type	Volts	Speed
1000	Whse. syn cond		4000/2300	900
625	Gen. Elec.	ATB	2300	450
600	Gen. Elec.	ATB	480	900
485	Allis Ch.	1 trg.	440	600
440	Gen. Elec.	TRH	240/480	450
312	Gen. Elec.	ATB	240/480	600
275	G. E. 25 cycle	ATI	480	750
235	El. Machy.		480	720
225	Gen. Elec.	ATI	240/480	900
156	Gen. Elec.		240/480	1200
150	Gen. Elec.	ATB	2300	900
150	Whse.		2300/480	600
125	Gen. Elec. (2)	ATB	240/480	900
75	El. Machy.		2300	900
66	G. E.	ATB	240/480	1200
25	Whse. (3)	3 phase	240	1200
25	Whse. b.b.	1 phase	120/240	900
10	Kato b.b. New	3 phase	127/220	1800

TWO 300 HP MOTORS—LIKE NEW
300 HP Gen. Elec. type M-568 silpring, 3/60/2200/440 V. 720 RPM, w/control.

D. C. GENERATORS

KW	Mfr.	Type	Volts	Speed
300	Al. Ch.	MRCW	125/250	1200
250	Allis Ch. b.b.	KW	250	1200
175	Allis Ch. b.b.	kW	250	900
150	Gen. Elec. b.b.	CDM	250	1500
105	Century b.b.	1500 amp.	70	1200
100	GE.	CD	250	1500
100	Allis Ch.	K	125	1200
100	Allis Ch.	K182	250	900
100	Reliance	651T	600	1200
75	G.E. b.b.	CD	250	1200
75	Cont. b.b.	D100X	125	1150
75	P.M. b.b.	DH	125	1800
75	G.E. b.b. (2)	CDM125	125	750
70	Whse.	8K	250	900
60	Allis Ch.	K147	250	900
60	Whse. b.b. (2)	8K121	300	1200
50	Cr. Wh. b.b.	CCD	250	1800
50	Whse.	8K150	250	1100
48	Whse.	8K140	250	1100
40	Gen. Elec.	RC32	600	1750
25	Whse.	8K93	125	1750
25	C.W. b.b. (2)	CCD	250	1200

A. C. MOTORS — 60 CYCLE

HP	Mfr.	Type	Volts	Speed
750	G.E.	Synch.	2300	514
700	Allis Ch.	Sq. Cage	440	900
600	Whse.	Sq. Cage	2300	3600
600	G.E. (3)	Synch.	2300/440	360
600	G.E.	Sq. Cage	4000	1800
500	G.E.	Silpring	2300/440	450
500	G.E.	Synch.	440	900
450	Allis Ch.	Synch.	440	400
400	Whse.	Sq. Cage	2300	514
400	G.E.	Synch.	440	450
350	Whse. (3)	Silpring	2300	450
300	G.E. (2)	Silpring	2300/440	720
300	El. Machy	Synch.	220/440	360
300	Al. Ch.	Sq. Cage	2200/440	720
300	Whse.	Synch.	2200/440	600
300	G.E.	Silpring	440	360
300	F. Morse b.b.	Silpring	440	600
250	G.E.	Synch.	220/440	720
250	Whse. (2)	Sq. Cage	2200/440	1200
250	L.A. (2)	Sq. Cage	2300	1800
225	G.E.	Synch.	220/440	900
200	Gen. Elec.	Sq. Cage	220/440	1200
200	F. Morse b.b.	Silpring	220/440	600
200	Reliance b.b.	Sq. Cage	220/440	1800
200	Allis Ch.	Silpring	440	450
200	Gen. Elec.	Sq. Cage	2200/440	720
200	Cr. Wh.	Sq. Cage	220/440	3600
200	Whse.	Sq. Cage	2200/440	900
200	E. M.	Synch.	220/440	1200
200	E. M.	Synch.	220/440	514
175	G.E. (3)	Synch.	220/440	720
175	Whse.	Synch.	220/440	300
150	Whse.	Sq. Cage	220/440	900
150	G.E.	Synch.	220/440	450
150	Allis Ch.	Silpring	2200/440	720
150	G.E. (2)	Sq. Cage	2200/440	720
150	Allis Ch.	Sq. Cage	2200/440	1200
150	Rel. b.b.	Sq. Cage	220/440	1800
150	Allis Ch.	Sq. Cage	440	450
150	G.E. vertical	Silpring	4000/2300	1200
125	G.E. TEFC	Sq. Cage	220/440	3600
125	Whse.	Sq. Cage	220/440	900
125	Rel. TEFC	Sq. Cage	220/440	1800
125	G.E.	Silpring	220/440	450
125	E. M.	Synch.	220/440	1800
125	Allis Ch.	Silpring	220/440	900
100	G.E.	Silpring	220/440	514
100	Burke b.b.	Synch.	220/440	1800
100	G.E.	Silpring	220/440	900

Our 49th Year—Check with Wagner First!

D. C. MOTORS

HP	Mfr.	Type	Volts	Speed
300	Allis Ch. b.b.	KW	250	1000
200	Allis Ch. b.b.	EW	250	650
175	Whse.	8K	230	800
150	Whse.	8K-201	230	200/700
100	Reliance	651T	550	1000/1600
100	G.E. dynamom.	TLC50	250	1000/4000
100	G.E.	CD123	230	1150
100	Allis Ch.	E182	230	600/1200
75	F. Morse b.b.	DH-140	115	1800
75	Whse.	8K175	230	625
60	G.E. dynamom.	TLC25	250	1000/3500
50	Reliance b.b.	651T	250	750
50	Cr. Wh. b.b.	FH	230	1750
50	Whse.	8K125	230	300/900
40	Whse.	8K140	230	775
40	Whse.	8K143	230	600/1500
40	Reliance	651T	250	350/1000
40	Gen. Elec.	RC32	550	1200
30	Imperial b.b.	D60	230	400/1600
30	Star b.b. (3)	8B	230	1750
25	Star b.b.	8B	230	1750
25	L. A. TEFC	RNA	230	950
25	Whse.	8K150	230	300/1200
25	Whse.	8K100L	230	1150
20	Century b.b.	DN326	230	3500
20	G.E. series	CO-1830	230	875

MOTOR-GENERATOR SETS

KW	Mfr.	Input V	Output V
500	Whse.*	2300 AC	250 DC
300	Allis Ch.	2200/440 AC	125/250 DC
250	Allis Ch.	2200/440 AC	350 DC
200	Cr. Wheeler*	2300/6150 AC	250 DC
200	Whse.*	220/440 AC	55 DC
200	G.E.*	220/440 AC	250 DC
200	Gen. Elec.*	220/440 AC	125 DC
150	Whse.	2200/440 AC	275 DC
125	Gen. Elec.*	2300/4000 AC	250 DC
105	Century b.b.	220/440 AC	70 DC
100	G.E.*	2300/440 AC	125 DC
100	Allis Ch.	220/440 AC	250 DC
75	Gen. Elec.	220/440 AC	250 DC
75	Cont. b.b.	220/440 AC	125 DC
66	Gen. Elec.*	220/440 AC	60 DC
60	Whse (2)	220/440 AC	300 DC
50	Gen. Elec.	220/440 AC	125 DC
50	Cr. Wh. b.b.	220/440 AC	240 DC
40	Gen. Elec.	220/440 AC	600 DC
30	Gen. Elec. (2)	220/440 AC	125 DC
30	F. Morse b.b.	220/440 AC	24 DC
25	Whse.	220/440 AC	125 DC
20	Gen. Elec.	220/440 AC	250 DC
15	El. Prod.	220/440 AC	40 DC

→ *Send for Stock List P-102* ←

ARTHUR WAGNER COMPANY
1435 W. RANDOLPH ST.
CHICAGO 7, ILLINOIS
TELEPHONE MONROE 6-7409

13 SPECIALS

1500 KVA GE 480 v Turbo. non-con.
937 KVA GE 480 v Turbo. non-con.
625 KVA Al Chal TURBO unit, non-cond. 3/60/480/240 v.
250 KVA (2) Wghse 380/480/240 v—7 cyl. DIESEL units
200 KVA (2) GE. 480/240 v—Buckeye 6 cyl. Diesels
1236 KVA F.M. DIESEL Unit 300 R.P.M. 33D16
800 HP (2) B&W 250# BOILERS
680 HP (4) B&W 260# BOILERS
500 HP (3) B&W 160# low head BOILERS
300 HP (2) Keeler 250# PACKAGE BOILERS
300 (2) B&W 160# low head BOILERS
250 HP (2) B&W 225# low head BOILERS
250 HP (2) Union 160# PACKAGE

POWER PLANT EQUIPMENT CO.
39 CORTLANDT STREET — NEW YORK, N. Y.

37 Years Dependable Service

SLIP RING MOTORS 3-Ph., 60 Cy.

H.P.	Volts	Make	Speed
600	2200	Whse.	450
500	2300/4000	G. E.	900
450	440	Whse.	514
450	440	Whse.	720
300	2300/440	G. E.	720
300	440	G. E. (Inst.)	600
300	2200	G. E.	360
300	440	Whse.	2000
250	440/220	Whse.	600
250	550/440	G. E.	1200
200	440/220	Whse.	514
150 (2)	440/220	G. E.	720
150	2300/440	G. E.	600
125	440/220	G. E. (Inst.)	600
125	440/220	G. E.	900
125	550/440	G. E.	1200
125	2300	G. E.	600

SYNCHRONOUS MOTORS 3-Ph., 60 Cy.

H.P.	Volts	Make	Type	R.P.M.
400	2300/440	G. E.	ATI	720
375	440/220	Whse.	O	900
350	440/220	El. Mach'y.	Sync.	1200
300	2300/440	G. E.	TS	720
300	2300/440	G. E.	TS	1200
250	2300/440	G. E.	TS	720
250	440/220	Whse.	HR	277
250	440/220	G. E.	ATI	900
125	440/220	Whse.	HR	400

SQUIRREL CAGE MOTORS

H.P.	Volts	Make	Type	Speed
600	2300	G. E.	FT	3600
500	2300/4000	Kiliek	SC	1800
500	2300	G. E.		450
400	2200/400	Whse.	CS	720
300	2300	L. Allis	FS	1800
225 (2)	2300/440	G. E.	KT	1200
200	440	G. E.	IK	720
200	440/220	G. E.	KT	1800
200	2300/440	G. E.	JK	1800
200	2200	G. E.	KT	1800
150	440/220	Whse.	CS	900
150	2300	Al. Chal.	AR	1800
150	220	Whse.	CS	1200
150	440/220	G. E.	IK	450
150	440/220	G. E.	KT	750
150	2300/440		KT	600

A. C. GENERATORS

1—320 kva, 660 rpm 2300/440/220 V., G.E.
1—300 kva, 900 rpm, 450/220 V., G.E.
1—225 kva, 600 rpm, 220/440 V., G.E.
1—200 kva, 720 rpm, 2300/440 V., G.E. (Ball)
1—187 kva, 1200 rpm, 2300/440 V., Whse.

CIRCUIT BREAKERS

2—2000 amp. OO K., 3 pole, 600 V.
2—1600 amp. ITE, 3 pole, 600 V.
6—FKR-155-28, 600 amp., 15,000 V., G.E.
1—FKR-142, 1200 amp., 4500 V., G.E., Sol. op. (new)

D. C. MOTORS

H.P.	Volts	Make	Type	Speed
225	230	Whse.	SK	2870
150	230	Whse.	SK	1750
140	230	Whse.	SK	400/1200
90	230	G. E.	CD	1750

MOTOR GENERATOR SETS

KW	Make	Input V., AC	Motor Type	Output V., DC
250	Whse.	2300	Syn.	250
175	G. E.	250/440	Syn.	230
125	G. E.	440/220	Syn.	250/125
100	Al. Ch.	220/440	sq. ca.	240/120
100	Whse.	440/220	sq. ca.	125
75	G. E.	2300/440	Syn.	125
60	G. E.	2300/440	sq. ca.	250

TRANSFORMERS 60 Cy.

1—600 kva, Standard, 13,800-2300 V., 3 ph.
3—500 kva, Whse., 66000—2300 V.
3—333 kva, G. E., 12000—2300 V.
3—300 kva, G. E., 2300—575 V.
3—300 kva, G. E., 11000—2300 V.
3—300 kva, G. E., 4150—480/240 V.
3—150 kva, Al. Chal., 2400—240/480 V.
6—100 kva, Whse., 2400—120/240 V.

only partial listing

STEPHEN HALL & CO.

HARRY J. RICE, Pres.
625 ADAMS ST., HOBOKEN 2, N. J.

3000 KW MODERN POWER PLANT—COMPLETE

NEW 1949 ***LITTLE USED***

3000 KW Turbo generator, Allis Chalmers 3600 RPM 3/60/2300/4600 Volts 400# 600° FTT cond. 28" Vac.

50000 lbs/hr Boiler, Union Iron Works, 450 psi incl. stokers with traveling grates

WITH ALL AUXILIARIES

ALSO:

1—1500 KW Turbo generator 3/60/2300 Volts 190# condensing, new 1927
2—1000 KW Turbo Generators 3/60/2300 Volts 190# condensing, new 1918
2—Boilers, 35000 lbs/hr 200 psi new 1935/37, incl. stokers

COMPLETE WITH ALL AUXILIARIES

HUGO NEU CORPORATION

31 Nassau St. Tel: REctor 2-1334 New York 5, N. Y.

BOILERS

9—304 HP, Kewanee, Firebox, Model 590, 125 PSI, ASME with soot blowers.
4—150 HP, Casey Hedges, HRT, 150 PSI, ASME, gas fired.
1—50 HP, Titusville, 150 PSI, adaptable gas or oil firing.

HEAT & POWER CO., INC.
70 Pine St., New York 5, N. Y.
HAnover 2-4890

FOR SALE

FAIRBANKS-MORSE DIESEL ENGINES

Model 32 E 14—2 Cylinder 150 H.P. @ 300 R.P.M. Almost New—Price Cheap!! 2-Available.

Write For Full Specifications

GLOBE TRADING COMPANY
1815 Franklin St., Detroit 7, Mich.
Phone WO 18277

1000 KW NONCONDENSING TURBO UNIT

1—1000 KW 80% P.F. 1250 KVA General Electric generator, 3 phase, 60 cycle, 2400 volts, 3600 RPM direct connect to
1—1000 KW General Electric noncondensing turbine, single stage, 150 lbs. steam pressure, 15 lbs. back pressure, 3600 RPM.

New 1920—Excellent Condition

INTERNATIONAL POWER MACHINERY CO.
1610 Union Commerce Bldg., Cleve. 14, O.

BABCOCK WILCOX

Boilers for sale at bargain prices, Two 600 HP and One 602 HP, 200 PSI Steel Sectional Headers, located Arkansas.

FS-5030, POWER
330 WEST 42 ST., NEW YORK 36, N. Y.

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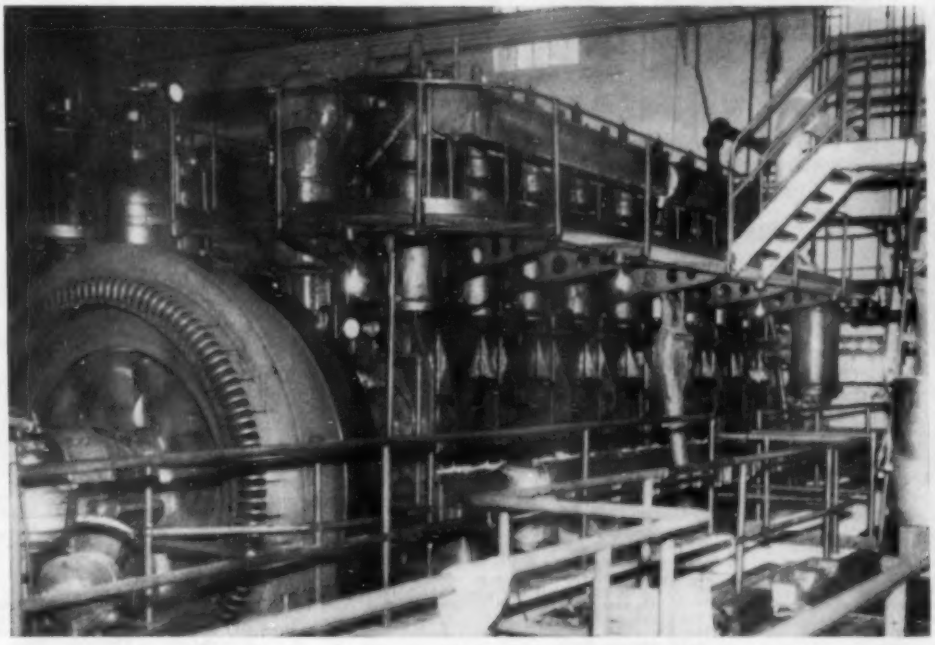
Some Town can Save Money with this DIESEL ENGINE BARGAIN



FOR SALE

1—900 H.P. 17x24 in., 8 cylinder, MacIntosh Seymour air injection Diesel engine, direct connected to 615 K.W. General Electric Company generator, 2400 volts, 60 cycles, 3 phase, and with a chain driven 13 K.W. exciter.

Installed new 1928: Muffler, Lub Oil Sump Tank.

The above equipment will be sold to the highest bidder. Bids to be opened at the Light and Power Office, Town Hall, March 8th at 8 P.M.

The equipment is open to inspection and will be in operation until sold. The successful bidder must dismantle and remove equipment at his (its) expense before May 1st.

Certified check of 10% of the amount bid will be required to accompany all bids submitted in this sale.

We reserve the right to reject any and all bids.

TOWN OF HUDSON, MASSACHUSETTS
OFFICE OF LIGHT AND POWER DEPARTMENT
TOWN HOUSE

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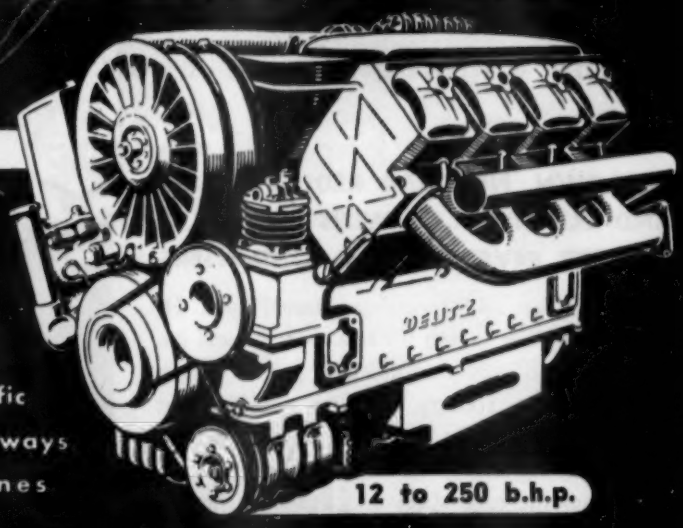

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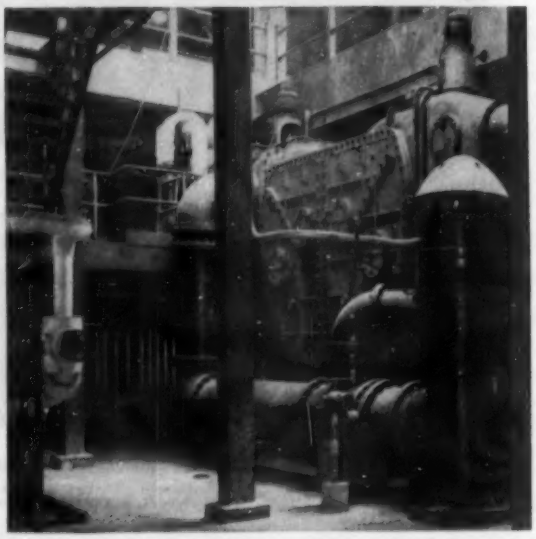

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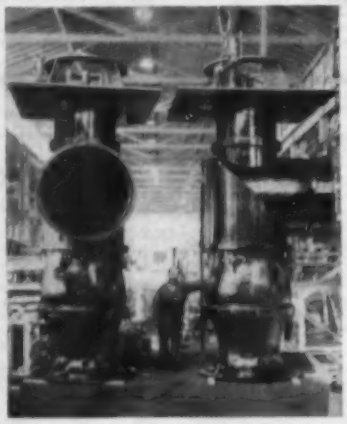

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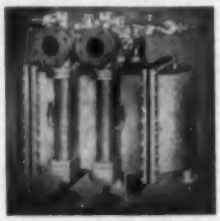

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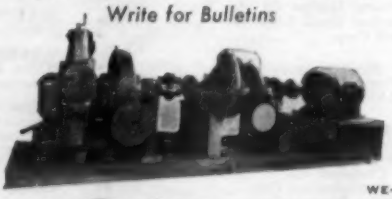

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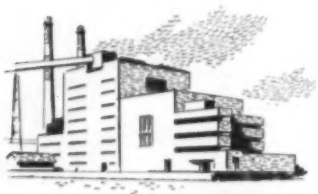
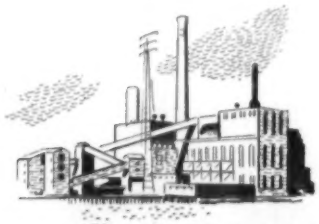


Salem Harbor Station in Salem, Mass.
Two 60,000 kw. units — '51 & '52



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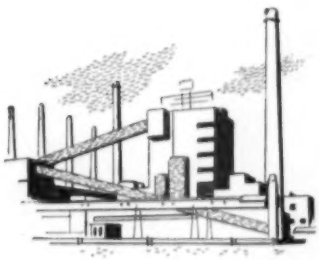
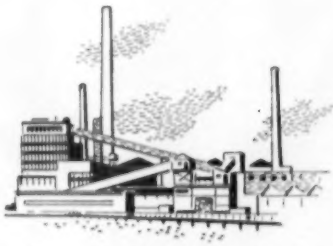


South Street Station in Providence, R. I.
55,000 kw. topping unit — '53



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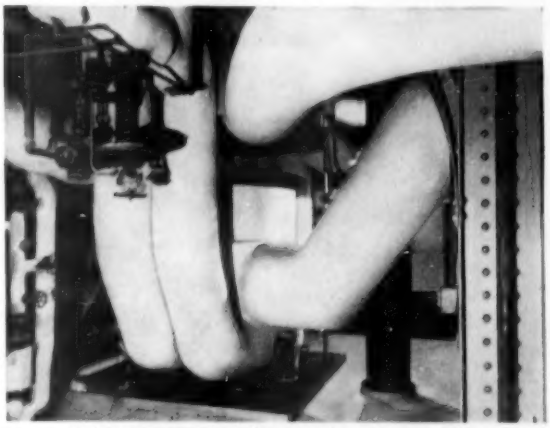

Main steam and reheat lines at reheat intercept valve, Salem Harbor Station.

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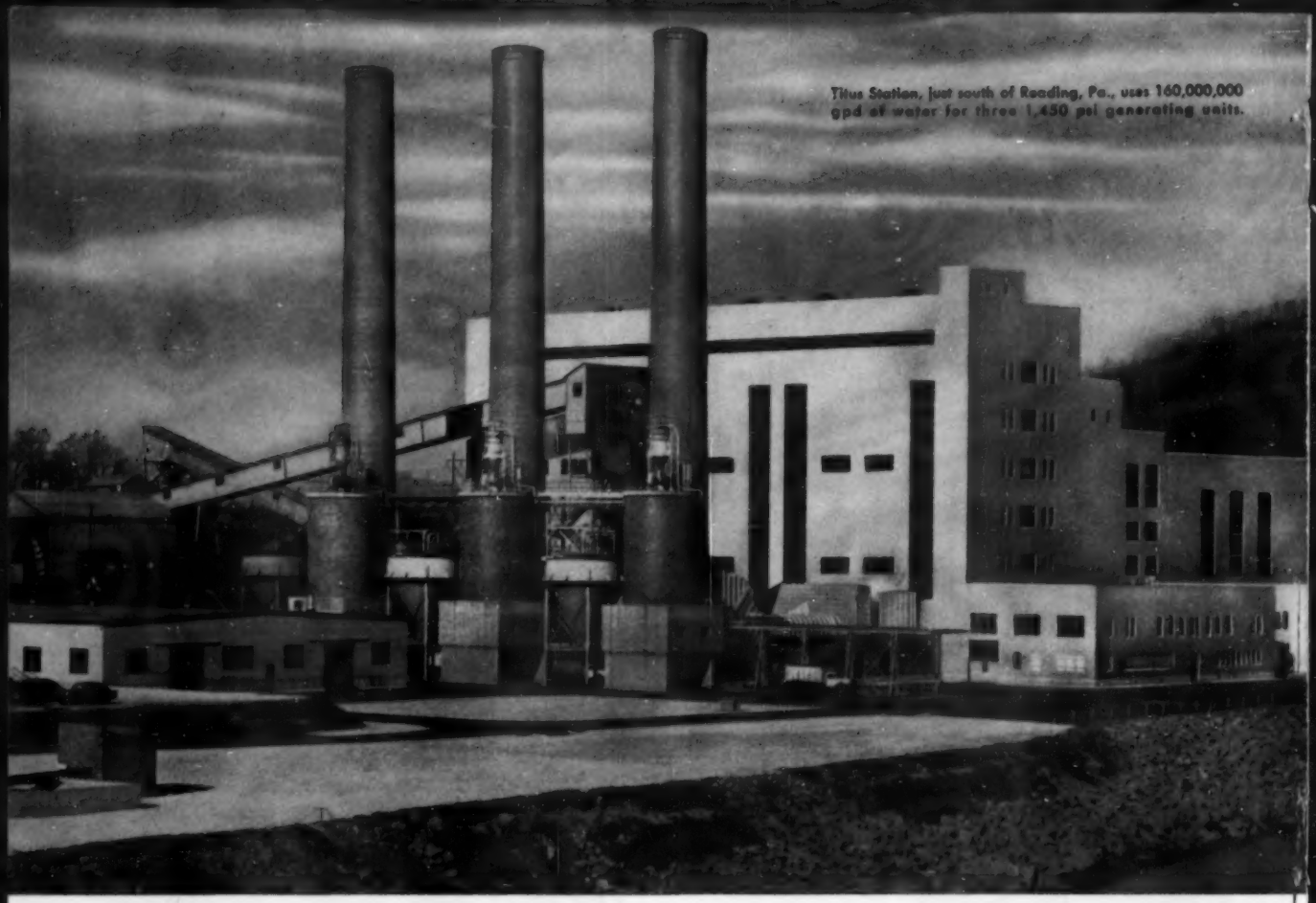

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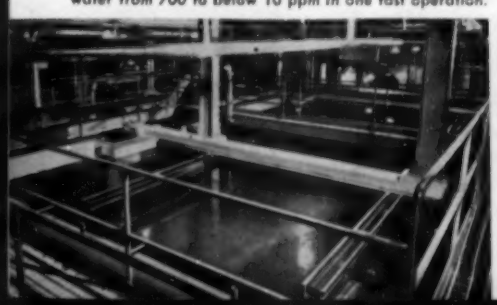

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